

COUPLING CONSERVATION EFFORTS WITH WATER RATE STRUCTURE: EVIDENCE  
TO INFORM LEADERSHIP AND SUPPORT POLICY

BY

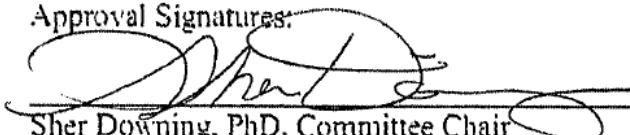
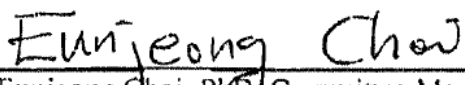
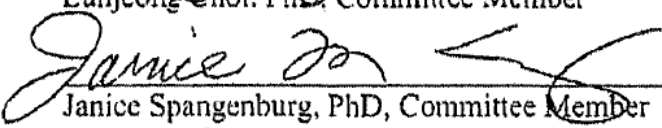

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## **ABSTRACT**

The purpose of this study was to identify data supported water rate structures that would promote sustainable agency revenue along with water conservation policy for long-term benefits to consumers and water agencies of Amador County in the face of increasing water scarcity. The theoretical foundation that provides the framework for this research is organizational change through sustainability (Doppelt, 2010) and requires leaders who understand the concept of sustainability and also have the skills to move change throughout the organization. The questions that the researcher addressed included which rate structures support agency revenue and which may encourage water conservation. A quantitative methodology was used to evaluate water consumption rates. This study focused on between-group differences of pre-existing groups of water consumers and is therefore casual-comparative in design. The data from three water use periods (pre-drought, drought, and post-drought) were analyzed using paired sample t-tests to determine if there was a statistically significant difference in revenue during those time periods. Random sampling selection of water users was appropriate and gave the researcher a good overview of resource consumption in various periods of conservation and non-conservation (Creswell, 2018). The data used for the paired sample t-tests did not show normality in all groups which was to be expected based on the variability in water demand among the consumer group. The p-values produced in the data analysis allowed the null hypotheses in two of the three tests to be rejected. Several factors were determined to effect normality of the data and are discussed in detail. The t-test for the pre-drought period showed that there was not a significant difference in revenue for the agency between the two different rate structures. The t-tests for both the

drought period and the post-drought period showed a statistically significant difference in the revenue for the Amador Water Agency. The difference in revenue was actually lower under the consumption-based fixed rate model than the traditionally used rate structures. While many of the consumers in the study group decreased their water consumption during the drought period, they still saw an increase in their water utility bills because of the change to the rate structure implemented by Amador Water Agency. The water agency appeared to be able to maintain their revenue through rate increases during the study period, but these rate increases likely do nothing to encourage conservation behavior. The calculated consumption-based fixed rate structure showed that when consumers reduced their water usage, they also reduced their water bill and therefore warrants further research as a model for aligning conservation and revenue stability in the long-term. The information gained from the research will remain beneficial to the water agency in determining the best rate structure for their organization to sustain revenue throughout periods of variable water consumption, predict revenue and costs over drought and non-drought periods of consumption, and give an increased focus and effort to conserving the water resources of the area.

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## **CHAPTER 1: INTRODUCTION TO THE STUDY**

The problem addressed in the research is the loss of revenue to local water agencies when conservation measures are implemented. The researcher sought to identify conservation-based rate structures that are coupled with revenue sustainability. A quantitative methodology was used to evaluate water consumption rates during different periods of drought and use those consumption rates to predict differing revenue sustainability using different rate structures. The research design included single stage sampling of the randomly selected water users served by the Amador Water Agency and included data from pre-drought, during drought conservation measures, and post-conservation rates. Data from the three water use periods for a specific time period were analyzed for use and coupled with analysis of cost and revenue for the agency. The data analysis completed by the researcher was supported through a confidence interval comparing the local data of the Amador Water Agency to expected data for the same sample group using a modified rate structure pricing system known as a consumption-based fixed rate.

### **Study Background/Foundation**

California has a unique need for water management based on its variable climates and sources of water as described by Escrivá-Bou, McCann, Hanak, Lund, and Gray (2016). The complexity of statewide management systems makes it challenging to support the financial health of the resource management organization and the environment. Much of the population of Northern California resides in areas rich in mountain runoff waters that not only supply surface water resources, but continuously work to recharge groundwater supplies. There are a variety of river systems that connect the water to the people of the area including the American River, the

Sacramento River, the Feather River and the smaller, but nonetheless important, Consumnes and Mokulemne Rivers, that serve as the main water supplies for residents of Amador County and beyond. California's climate is characterized as Mediterranean which translates to a generally dry, hot summer coupled with a wet, cold winter. The natural flora and fauna of the region are well adapted to these conditions. However, periodic and long-lasting droughts can take a heavy toll on the ecosystems. California historically experiences multiple year droughts alternating with what are considered average years, with other years being high in precipitation. As the population of the state, and specifically Amador County, continues to grow, planning and managing water resources becomes even more critical in the pursuit of sustainability.

Accounting for California's water requires a commitment by state and local governments in order to best prepare for both periods of drought and an uncertain future (Escriva-Bou et al., 2016). Scientific models can provide government agencies with valuable data to aid in the prediction and planning process, but these models should serve as a guide and not as the only source of information to consider. If true sustainability is the goal, both financially and environmentally, then heavy consideration of unpredictable and highly variable weather needs to be a key factor in the water utility planning process. When an area has a water source that is dependent upon the climate, it makes the water reliability factor decrease according to Fulton, Cooley, and Gleick (2014). Using a water footprint assessment of the area can help local authorities determine the most sustainable way to address their needs. Currently, water conservation measures are the general responsibility of the consumer. However, as water scarcity, food costs, concerns for safety, and other factors of instability increase, Marrin (2016) suggests it should encourage

governments to further regulate consumption of water both directly and indirectly. A recent World Health Organization Report (2017) stated that food shortages are on the rise after many years of decline, indicating that approximately 11% of the world's population or 815 million people are currently suffering from food scarcity. The main causes of food shortages are linked to increasing numbers of violent conflicts and climate related issues rendering certain populations less able to grow or otherwise access food (World Health Organization, 2017). Predictions of a global population are at approximately 10 billion by the year 2050 which makes clear the need for national, state, and local agencies to plan for ever increasing demands on systems that supply food, water, and other basic necessities to people (World Health Organization, 2017). Amador County is situated at the base of the Sierra Nevada Mountains and meets up with the bordering Central Valley in which the majority of California's crops are produced. California is well known as a top global producer of items such as almonds and dairy products. Agricultural systems operators require water to produce their goods and this increases competition in the global water market. All of these factors make it imperative for local utilities to consider a long-term approach to their water management plans.

Local water agencies currently report a lack of funding for many projects including system upgrades and general maintenance. This scarcity is due in part to conservation requirements imposed on the organization and the customers that they serve under the statewide conservation mandates in times of prolonged drought (Amador Water Agency, 2017). Based on the loss in revenue for the sale of water, the agencies may have less funds available to do the necessary research for the area now and in the future. This type of research is important for

planning and management purposes. Rapid assessment approaches to gathering data to provide a real time analysis of the water demands for an area. This assessment type may benefit local water agencies that do not have the funds to develop hypotheses or to conduct observational studies that are recommended by Barreau et al. (2017). These studies may contribute widely to the understanding of water use and lead to water conservation strategies that are sustainable. Water rate structures are the main way water utilities recover the cost of services, maintenance, etc. Certain rate structures impose larger fees on heavy water users, while other structures apply a one size fits all approach in a flat fee rate. When conservation of water is implemented by customers, those in a tiered structure end up paying less in water fees based on the fact that they are using less water during times of conservation and therefore, the revenue of the agency also decreases. In a way, this type of rate structure may be an incentive for the customer who is saving money, but is simultaneously hurting the agency in terms of revenue losses. There are many challenges to water conservation rate structures that can be overcome if properly implemented, and according to Mukherjee, Mika and Gold (2016) these may include setting rates proportionally with the cost of providing the water, building in conservation costs, and adding penalties for excessive use. Planning ahead for variable situations and avoiding reactionary responses to drought may be beneficial for both the consumer and the local water agency.

### **Problem Statement**

The problem is the loss of revenue to local water agencies when conservation measures are implemented. Some areas that are provided water in Amador County obtain water from highly variable sources including ground and surface water sources making the access,

maintenance and distribution of this water more or less costly depending on the source. Applying a one-size-fits all rate structure to such a variable customer base does not allow the water agencies to equitably charge customers for the product (Mukherjee, Mika & Gold, 2016). Furthermore, during times of mandatory conservation, the agencies may be forced to charge customers an addition to their regular rates as an incentive to conserve (Mukherjee, Mika & Gold, 2016). When agencies see a decrease in water usage during conservation, they also experience a loss in profits unless they approach conservation rate restructuring in a way that targets the heaviest consumers of water and not simply all users (Mukherjee, Mika & Gold, 2016).

### **Purpose of the Study**

The purpose of this study was to identify data supported water rate structures that would promote sustainable agency revenue along with water conservation policy for long-term benefits to consumers and water agencies of Amador County in the face of increasing water scarcity

### **Methodology Overview**

A quantitative methodology was used to identify water consumption rates by drought periods and compare those consumption rates to consumption-based fixed rates being used by other agencies to both promote conservation efforts and stabilize revenue. Spang, Miller, Williams, and Loge (2015) describe the consumption-based fixed rate structure as a type of harmonized structure based on the dividing of revenue requirements into three categories which align and allocate fixed and variable costs to customer by volumetric pricing. The population size of the local water agencies is approximately 15,000 people. The research design is both

descriptive and comparative in nature, making it casual-comparative in design and included single stage sampling of the randomly selected water users for Amador Water Agency. It included data from pre-drought, during drought conservation measures and post-conservation rates. The three different consumption periods allowed for a description of the water consumption in the area of Amador County and for the comparison of the currently used rate structures to that of a consumption-based fixed rate structure. The consumption periods gave data to support the best rate structure for long-term organizational sustainability. The data from the three water use periods for a specific time period was analyzed for use and coupled with analysis of cost and revenue for the agency under both the currently used increasing block rate structure and the harmonized consumption-based fixed rate structure. This data was used identify possible changes to the current rate structure of the Amador Water Agency that would both support conservation efforts and stabilize revenue for the agency.

### **Research Questions**

1. Is there a measurable difference in revenue for the differing rate structures of tiered and consumption based fixed rate between the water consumption periods of pre-drought, drought, and post-drought?
2. Does the revenue remain more stable for the water agency using a particular rate structure?

### **Hypotheses**

- H1<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the pre-drought period.
- H1 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the pre-drought period.
- H2<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the drought period.
- H2 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the drought period.
- H3<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the post-drought period.
- H3 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the post-drought period.

### **Study Limitations**

Within this study some of the reporting procedures, timeframes, and history may be variable between the different water agencies and therefore pose a challenge in comparing water rate structure and conservation efforts. One or more of the agencies in the geographical area does not appear to have attempted water conservation efforts and therefore the data in this category may be deficient. The Amador Water Agency did publish and has made available for the public both its Urban Water Management Plan in 2015 that includes a chapter addressing conservation measures, and a more specific Water Conservation Plan in 2010. Following this conservation

publication, severe drought affected most of California and a statewide reduction in water usage was implemented. These circumstances may have affected the consumption behavior of the consumers to varying degrees. During the California state of emergency drought period of 2015-2017, a required reduction in water use of 25% was put in place while the Amador Water Agency repeatedly downplayed the need for conservation and cited less than 10 residents for non-compliance according to their records (AWA, 2017). This lack of promotion of conservation may have had an effect of the actual amount of water conserved by consumers, and within a district that strictly enforced reductions, there may be an even greater difference in the water demand between periods. These variations were not measurable through the data collected since the variety of reasons consumers used more or less water during different drought periods cannot be identified simply through water consumption rates.

### **Definitions of Key Terms**

*Drought.* A period of drier-than-normal conditions that result in water related problems (USGS, 2018).

*Ground Water.* Water that is found below Earth's surface (USGS, 2018).

*Rate Structures.* A fee designed for consumers that is meant to cover the costs associated with treatment and delivery of safe drinking water (AWWA, 2017).

*Surface Water.* Streams, rivers, lakes, and reservoirs are collectively considered Earth's surface water (USGS, 2018).

*Sustainability.* The ability to meet the needs of the current generation while not compromising the needs of future generations (Doppelt, 2010).

*Water Conservation.* A commitment to maximizing available water resources and minimizing the need to obtain additional water supplies through utilizing water management tools and developing strategic partnerships with upstream, downstream, and nearby agencies and districts (AWA, 2015).

*Water Footprint.* The quantity of water used in both direct and indirect manners throughout its production chain (Marrin, 2016).

*Water Scarcity.* The depletion of freshwater sources which reduce the volume of water remaining for further human use and ecosystem support (Richter et al., 2013).

### **Summary**

The purpose of this study was to identify data supported water rate structures that would promote sustainable agency revenue along with water conservation policy for long-term benefits to consumers and water agencies of Amador County in the face of increasing water scarcity. Through research combined with local analysis for conservation and revenue sustainability specific to the rural California region of Amador County, better informed policy can be made by water managers.

## **CHAPTER 2: LITERATURE REVIEW**

### **Introduction**

The purpose of this literature review is to identify potential gaps in the research in water rate structures specifically for rural areas that may improve conservation and revenue sustainability.

All around the world water resource managers are struggling to address the need for access to additional water resources because of increased demand. As populations continue to rise, as described by Richter et al. (2013) in a study focusing on cities securing water for the future, upwards of 50% of cities globally exist in water-scarce basins and therefore, are unable to sustain themselves with their own domestic supplies. Historically, most water management has followed a similar pattern of first exhausting the domestic surface water resources, followed by the need to import water from other areas, and finally turning to recycling of wastewater on some scale (Richter et al., 2013). As populations continue to grow and climate change increases water resource vulnerability, it is becoming ever more critical that water districts manage this resource on a scale that addresses their unique needs.

Rate structures are one main approach to water management and vary greatly from district to district. These rate structures are described by Boyer, Adams, Borisova, and Clark (2012) in a study of factors that drive water rate structures and can include increasing block rates (IBR), decreasing block rate (DBR), and uniform rate (UR) structures. All rates have different purposes that might incorporate revenue needs and conservation management. In the past only the cost of water delivery was considered in the rate adoption for a particular district, but there is

a trend to also include fairness to end users, legal constraints, and the perspectives of the managers themselves (Boyer et al., 2012). As the population of most areas of California continues to grow, including rural districts, water managers must consider many factors such as the expansion of the delivery system, maintenance of aging infrastructure, and conservation of the resource that is potentially unstable when adopting rate structures for their unique district. A one-size-fits-all system of analysis and distribution does not work to support accuracy in a state that is unique in its needs, topography, climate and regulations.

California is unique in terms of water resources based upon both source reliance and consumption. California depends more on surface and groundwater as its primary sources of water for consumption compared to national averages. This makes California subject to greater vulnerabilities and increasing the complexity of water management (Fulton, Cooley & Gleick, 2014). To further highlight the complexity of the water management system, the size and distribution of use within California must be considered. California hosts approximately 1/8 of the nation's population and produces 1/8 of the nation's gross domestic product which requires large amounts of water in the production of goods and use by consumers (Fulton, Cooley & Gleick, 2014).

The current literature in the field of water management clearly points to the need for water analysis and rate structure approaches that are tailored to the specific demands of each particular water management district. California management needs are different from those of much of the rest of the United States. Within California, the diversity of water needs is increasing based on multiple factors including topography, climate, population potential, and the

many vulnerabilities that the state faces because of reliance on external water sources and climate change (Fulton, Cooley & Gleick, 2014).

Vulnerabilities such as drought cycles increase the need to incorporate sustainability planning into water management. Sustainability must include access to water for continuance of services along with the financial sustainability of the water district itself. Sustainability should be approached on a local basis taking into account the public perceptions, demands on the resource, and conservation strategies to ensure long term access and reliability.

Amador County is rural and has a relatively low population that is dispersed over large areas necessitating water analysis and rate structures that will continue to support both the domestic and agricultural users in these districts. Since these are small, isolated areas of California, there has been no research literature published addressing the needs of these particular foothill counties outside of the long-term needs studies privately contracted by the water agencies themselves. Unbiased water analyses are needed for these areas and other rural districts to ensure that management of water as a resource is carried out in a way that promotes both financial and environmental sustainability and informs policy making decisions that can support long-term sustainability of water resources.

### **Key Theories**

The literature review to date has not revealed any specific working theories for the proposed research. However, leadership theories focusing on transformational and situational leadership appear to be applicable to this research since much of the conservation efforts undertaken by local water utilities are driven mainly by policy implemented by federal, state and

local governments. Requesting volunteer conservation actions have historically yielded much lower reductions in water use. Data shows a 3% decrease compared to districts that use fiscal impacts with consumers at 30% water savings (Mukherjee, Mika & Gold, 2016). The Path-Goal Theory of leadership also informs the topic of revenue and conservation within the field of resource management through facilitating the understanding and alignment of resources goals so that leadership can communicate to consumers the need for conservation and potential rate structure changes. Leader-Member Exchange Theory helps the leaders better understand the importance of creating strong and stable relationships with the community to be able to successfully implement changes in consumer behaviors and perceptions of the management of water.

**Situational Leadership** addresses leadership adaptations in different situations over time and requires that the leader be able to adapt and change their leadership style as the situation changes as described by Northouse (2018) in a leading text of leadership theory. A leader applying the situational leadership style in a local water agency should have a good understanding of the entire situation revolving around conservation as it applies to that particular organization. Some of the factors that need to be understood and addressed by the leader would include the water supply, laws and policy governing the use of the water, and the water demands by its customer base. Knowing how each of these factors affect each other could allow the leader to adapt directive and supportive leadership to ensure that during times of conservation policy it is constructed, supported, and maintained to meet state requirements and also to sustain the organization.

**Transformational Leadership** requires that the leader understands what motivates those that they lead and helps those people to accomplish exceptional goals within the organization (Northouse, 2018). Work on the theory of transformational leadership was presented by Bryman (1992) as part of the New Leadership paradigm (Northouse, 2018). People are generally very concerned with their personal rights to water usage and are less concerned on a daily basis about their individual impacts to the overall water system. Water rate increases to support conservation efforts or any other reason have been widely unsupported in the Amador County water districts. It will require a leadership style coming from the local water agencies that incorporates the needs with an understanding of the desires of the customers into the decision-making process for achieving goals associated with conservation and revenue retention. The community will likely need to become a larger part of that planning process to allow greater buy in and support for proposed changes to the system.

**Path-Goal Theory** focuses on how the leader is able to motivate those that they lead through accomplishing a set of established and well-defined goals (Northouse, 2018). The leader must be able to determine what is missing from the working environment of the organization and then use that information to meet the needs of the organization (Northouse, 2018). Path-goal theory first appears in leadership literature through work by Evans and House separately in 1970 and then again in 1971 (Northouse, 2018). The needs of resource consumers are clearly the resource that they are consuming, and secondly, the financial value.

**Leader-Member Exchange Theory** presents itself in a slightly different way than other leadership theories that mainly focus on the views of the leader. This theory describes the

interactions between the leader and those that follow as a process (Northouse, 2018). Dansereau, Graen and Haga first described the theory of leader member exchange in 1975 (Northouse, 2018). Leaders that can create strong organizational environments can gain much in the way of stability and innovation (Northouse, 2018). Within water resources there are many relationships that must be managed including those with staff, the community, and the consumers of the water. The framework that will guide this research is organizational change through sustainability. The idea as discussed in depth and with many examples by Doppelt (2010) is a foundational guide to changing management. Sustainability for an organization that manages natural resources can aim towards both the sustainability of resources and the sustainability of the organization through financial stability in the long term.

Organizational change towards sustainability requires leaders that truly understand the concept of sustainability and also have the skill to facilitate change throughout an organization. As this concept applies to the local water districts of Amador County, the leadership needs to understand the resistance they may encounter as they implement changes in rate structure and how to best approach the consumers, as well as the governing board members. The leaders should have sufficient support for the idea through effective analysis while at the same time, ensuring that the presented data, ideas, and proposals for change are understandable to all stakeholders, as well as making sure that this information is communicated effectively to the public.

### **Water Management and Conservation**

With populations increasing worldwide, water districts must take into consideration the scarcity of water in their region, as well as surrounding regions. Long-term growth must be planned for (Richter et al., 2013). One of the most promising areas for water conservation is through partnerships between urban and agricultural water users (Richter et al., 2013). This relationship will help to mitigate losses during irrigation, and therefore, increase the overall water supply (Richter et al., 2013). Globally, people are struggling to access additional water as populations continue to grow. The typical water management pattern that has been observed starts with depletion of local surface waters, importing water from other water basins and then finally moving to some form of water recycling which is undesirable in terms of sustainability (Richter et al., 2013). Over half the cities in the world with populations greater than 100,000 are already situated in water scarce basins (Richter et al., 2013). Conservation of water resources in one area of use contributes to the overall increase of water supply for all users. However, water management has historically focused more on accessing greater amounts of water rather than decreasing the overall demand (Richter et al., 2013). The traditional pattern for water management has been to deplete local sources, import external sources of water and then turn to recycling of wastewater to meet the water needs of the district (Richter et al., 2013). With this realization, there is an identified need to understanding new approaches to supplying water. Conservation analyses need to be done on a local basis. Integration of water conservation in the planning process is needed by water management systems worldwide. Formation of water relationships between urban and agricultural users is needed. An assessment of the diversity of water use locally must be integrated into the planning for water management, as well as ways to

build relationships that support the conservation in different sectors, that will help to improve the overall local water supply.

Methods for assessing water needs in the future are inconsistent across the California water management systems. The task of properly assessing the future water needs is difficult as described by Diringer & Cooley (2017) in a review of the long-term needs and water supply for Amador County. The local agency, in their assessment of future water needs, has underestimated the effects of existing standards and conservation programs on water demand. Also, the estimation of population growth is inconsistent with demand forecasting, and they have overestimated agricultural water use (Diringer & Cooley, 2017). Water demand forecasts must include confidence intervals of high, medium and low, be consistent with regional and national forecasts and acknowledge a potential for high variability in the forecasting based on its rural nature (Diringer & Cooley, 2017). The local water agencies should redirect efforts to developing a long-term supply report that utilizes reliable data and uses that report to guide policy decisions that further the cause of sustainability to the organization and the local environments.

The current water supply may not be adequate to meet the needs of the service area of Amador Water Agency and will require additional water access to meet the projected needs. The population continues to grow in California including the rural area of Amador County as described by Woodward & Curran (2017) in the Amador Water Agency (AWA) long-term water supply and needs study. Climate change models predict temperature increases to be the most significant factor in increased water demand for the Amador County area. This use will increase the demand for water mainly due to projected increases in temperatures for the Northern

California area models (Woodward & Curran, 2017). The most accurate and up-to-date climate models for the area are needed to best project water supply and needs as population continues to grow (Woodward & Curran, 2017). A clear understanding of what influences consumer water demand is needed to manage the water supply (Woodward & Curran, 2017). In order for the AWA to most accurately determine projected water needs for the area, they will need to better understand how climate and consumer behavior are currently affecting water demand as a way to project future demand.

### **California's Complex Water Supply**

Understanding the water supply in California is critical to proper management of the state's supply of water (Escriva-Bou, McCann, Hanak, Lund, & Gray, 2016). California is a geographically diverse state that is both connected physically and disconnected institutionally with water systems that are made of a massive network of smaller, independently operated water districts. This generates complexity in determining the actual balance of available water for current and future use (Escriva-Bou, et al., 2016). California's climate is highly variable and warrants the need for a more reliable system of water needs assessment (Escriva-Bou, et al., 2016). Understanding the availability of water in such a diverse system is necessary for informing policy (Escriva-Bou, et al., 2016). Development of a common water accounting system is needed to accurately assess the water supply in California. An oversight committee made up of key stakeholder groups is needed to oversee the development of a common assessment system. A better definition of groundwater accounting is needed along with a clearer definition and policy for environmental water needs (Escriva-Bou, et al., 2016). The

development of local accounting systems that align with, at minimum neighboring water districts, especially those that currently or in the future may be sources of imported water, are needed. A strong water accounting system will allow local agencies to develop policy that support multiple aspects of the water system including consumer and environmental demand. In a case study of California on maladaptation to drought, Christian-Smith, Levy, and Gleick (2015) describe the connections between the demands consumers put on water systems and the natural availability of water. These relationships are complex and require system adaptations to stresses or changes. Water systems in California appear to have been fairly resilient over time, but lack consideration of long-term impacts to other related systems that also rely on the same water sources (Christian-Smith, Levy, & Gleick, 2015). Droughts are one example of situations that promote water scarcity, require reactionary responses by water managers, and impose burdens on the systems that are not completely understood (Christian-Smith, Levy, & Gleick, 2015).

Adaptive capacity for water management systems would allow the system to avoid risk and reduce vulnerability (Christian-Smith, Levy, & Gleick, 2015). Historical responses in California by the agricultural and energy sectors have been maladaptive based on their increased reliance on alternative water sources during times of drought that increase the overall energy demand for the state (Christian-Smith, Levy, & Gleick, 2015). Strategies for accessing additional water sources during times of stress leads to increased system vulnerability (Christian-Smith, Levy, & Gleick, 2015). Groundwater extraction nearly doubles in order to compensate during times of drought, and there are few legal constraints on the process (Christian-Smith, Levy, & Gleick, 2015).

Improvements in water efficiency, especially in the agricultural sector, can help to maximize the

available supply and reduce impacts on other sectors such as domestic consumers and the environment (Christian-Smith, Levy, & Gleick, 2015). Historical local climatic event studies are needed to properly understand trends in specific water districts and then use the data to predict long-term climate stresses that may impact water management policy (Christian-Smith, Levy, & Gleick, 2015). California must develop strategies that allow a shift from crisis driven management to a system that works continuously to mitigate impacts to water systems (Christian-Smith, Levy, & Gleick, 2015). In order to focus on long-term management of water resources in specifically unique water management districts, historical climatic data should be incorporated into policy decisions.

The effectiveness of integration of water footprint (WF) data into policy for water management is needed to address water needs in California (Fulton, Cooley & Gleick, 2014). California's water footprint is more externalized than other states and relies more heavily on surface and groundwater than other states making California's water systems highly vulnerable (Fulton, Cooley & Gleick, 2014). In an article discussing the use of water footprints, Marrin (2016) describes the need for their use as a necessary means for assessing conservation strategies. Increasing population along with climate change factors effect water systems at a regional level causing fluctuations in water availability (Marrin, 2016). Assessing water needs must include everything that is produced by the system, consumed by the system, and utilized directly by humans and the environment (Marrin, 2016). Scaling analyses to state or more local levels allows for greater accuracy in understanding water needs and associated vulnerabilities (Fulton, Cooley & Gleick, 2014). Water managers must consider and incorporate the importance

of outside water sources in policy decisions (Fulton, Cooley & Gleick, 2014). There needs to be a stronger link between water footprints and other qualitative factors for making policy decisions (Fulton, Cooley & Gleick, 2014). Policy is needed to address potential water scarcity now and into the future as increasing water demands continue (Marrin, 2016). A water footprint analysis for the area of Amador County would help contribute to the understanding of the overall water balance and supply. Having this data could inform policy that helps to minimize the current and future need for outside water resources.

### **Rate Structure**

The ability to use water demand data to identify important factors that impact water demand categories including temperature, drought and income factors are significant contributors to resource management. These are described by Ashoori, Dzombak & Small (2016) in a paper modeling the effects of conservation, demographics, price, and climate. Price is a significant factor in all demand categories with the exception of single-family households and is therefore a very effective conservation tool (Ashoori, Dzombak & Small, 2016). Price and conservation have significantly helped to counteract the demands on water systems placed there by increases in the population (Ashoori, Dzombak & Small, 2016). Understanding the drivers of water demand will help in sustainability planning and forecasting water demands including water system stressors such as climate change and increasing populations (Ashoori, Dzombak & Small, 2016). Tiered water rate structures give consumers monetary incentives to conserve (Ashoori, Dzombak & Small, 2016). Water rate structure coupled with educating consumers regarding conservation needs and techniques are effective strategies in reducing water demand (Ashoori,

Dzombak & Small, 2016). Lower income households tend to have less of a demand for water, while higher income households have an increased demand presumably from greater outdoor landscape irrigation (Ashoori, Dzombak & Small, 2016). Water demand data should include more accurate indicators of socioeconomic status to further understand water demand and promote conservation measures (Ashoori, Dzombak & Small, 2016). Each local water agency should gather data based on subcategories of income and water demand in order to better understand where the greatest concentration of conservation efforts need to be focused. If the single-family household is conserving less in times of drought, then conservation price tier and education efforts could be focused towards this subgroup.

There are multiple reasons for rate structure decisions including the perceptions and attitude water managers have regarding what is needed to sustain the organization and what they believe will be accepted by the consumers (Boyer, Adams, Borisova, & Clark, 2012). Other factors that are involved in determining the specific rate structure adoption for water districts include fair pricing, constraints on qualifications for grants and loans, concerns for the sustainability of revenue, and overall investment needs (Boyer, et al., 2012). Historically, rate structures were adopted with only covering the costs of operating in mind (Boyer, et al., 2012). By selecting rate structures that only cover these operating costs, water conservation is not encouraged (Boyer, et al., 2012). Water demand is strongly tied to pricing. As the cost to provide the water fluctuates, a uniform rate structure would provide a reliable and steady revenue stream, but does nothing for encouraging water conservation (Boyer, et al., 2012). Water rate structure adoption is heavily influenced by cost of delivery and perceived importance by the manager in

covering non-water delivery costs such as treatment and conservation programs (Boyer, et al., 2012). The cost of water is a key signal used to determine water demand and therefore to inform management decisions (Boyer, et al., 2012). Conservation of water is negatively impacted by rate structures that are uniform since there is no financial incentive for the consumer to conserve (Boyer, et al., 2012). Constraints to water management brought on by government grant and loan requirements, fairness to consumers, and the ability to increase revenue negatively impact adoption of an IBR because this rate structure is associated with decreased water use by the consumers (Boyer, et al., 2012). A more nuanced view is needed because some factors increase UR adoption while others increase IBR rate adoptions and additional study is needed to determine factors that are driving rate structure adoption (Boyer, et al., 2012). Similar to the variability in water resources that cover the state of California, the factors that drive rate structure adoption are likely to be just as diverse. It would be most beneficial for every water district to assess their own factors as they apply to rate structure adoption. A study is needed to determine the factors driving policy decisions in the Amador County region of California.

Rate setting approaches can be effective ways to encourage water conservation by customers and to comply with legal requirements set by the state (Mukherjee, Mika, & Gold, 2016). Mandatory reductions in water use set by state legislation in California were met with widespread resistance by both consumers and water utilities (Mukherjee, Mika, & Gold, 2016). Constraints on water management systems by legislation is prohibitive in allowing agencies to change rate structures without proving direct relations with cost and fees (Mukherjee, Mika, & Gold, 2016). Tiered rates reduce water use by an average of 25% and are one of the most

effective mechanisms in conservation strategy (Mukherjee, Mika, & Gold, 2016). Droughts force consumers to reduce use and may negatively impact agency revenue in the process (Mukherjee, Mika, & Gold, 2016). There is a lack of incorporation of factors effecting water pricing including rising treatment costs and variability in distribution costs when attempting to account water costs to agencies (Mukherjee, Mika, & Gold, 2016). Conservation strategies are needed and must reflect sustainability long-term, both financially and environmentally (Mukherjee, Mika, & Gold, 2016). Setting rates based upon the difference in water supply sources to reflect the actual costs of the water services as it varies based on area is needed (Mukherjee, Mika, & Gold, 2016). Better incorporation of the costs for storage, supply, and treatment should be included with the cost of delivery (Mukherjee, Mika, & Gold, 2016). Agencies should incorporate rates for water conservation programs into the rate structure and set rates that penalize overuse (Mukherjee, Mika, & Gold, 2016). Agencies could develop a conservation program for the local water management systems that is based on their own water supply demands. The conservation program must be aligned with state regulations and work to inform policy that contributes to long-term sustainability of the water management system.

With increasing demand on water systems due to several factors including increasing populations, residential water demand appears to be inelastic at current prices. When water utilities increase water rates, it often appears to consumers only as a way of increasing revenues when presented in the absence of other conservation measures (Romano, Salavti & Guerrini, 2014). An article by Romano, Salavti, and Guerrini (2014) discusses how larger water districts in drought prone regions are more sensitive to the promotion of reducing household water

consumption and are often underutilizing promotional campaigns for water conservation. There are several factors that influence the decision of policy makers to promote the reduction of water demand through educational campaigns (Romano, Salavti & Guerrini, 2014). Conservation techniques can include educational campaigns, financial incentives, pricing changes, and supply restriction (Romano, Salavti & Guerrini, 2014).

Research is needed in the areas of the roles water utilities play in promoting water conservation, the factors that influence the decisions of water utilities in promoting water conservation, and the role water utility ownership has in promoting water conservation based on the need to sell water (Romano, Salavti & Guerrini, 2014). There is also a need to monitor the effectiveness of these educational campaigns and to increase the amount of data on the best and most effective campaign practices (Romano, Salavti & Guerrini, 2014). Local water agencies should document their current efforts in promoting conservation including the use of web campaigns, and explaining decisions that have led to the implementation of conservation efforts or the lack thereof. They should take into consideration their role in maintaining or increasing revenues that have promoted water conservation and collect data to analyze the most effective practices leading to conservation for local water utilities, then use this information to develop policy and strategy for future efforts.

California has a major priority in water conservation and this is governed in part through legislation that local water agencies must support. Local factors such as climate, price policy, and estimation methods are all factors needed for policy implementation and interpretation and are described in a paper about price elasticity in water demand for California (Lee and

Tanverakul,2015). Consumers on larger plots of land and lower income households tend to react more to price changes. With this information, resource managers can better set prices in a way that sends clear messages of expectations for all users, especially those who are demanding more of the system (Lee & Tanverakul, 2015). Increasing block rate structuring is a strategy that can help to balance finances, as well as decrease consumer consumption of water (Lee & Tanverakul, 2015). A decreased demand in water consumption is strongly associated with price increases, providing evidence to water managers that can help in determining the best rate structure for their consumer population (Lee & Tanverakul, 2015). Water utilities need access to models detailing characteristics of consumers, so that they can design effective management programs and improve their understanding of how customers respond to price changes (Lee & Tanverakul, 2015). With detailed information of the dynamics of the consumer base characteristics, policymakers could make careful consideration of the types of tiers and price percentages used in their revenue structure when trying to manage for conservation and finance (Lee & Tanverakul, 2015). Local water agencies need to be able to study what effects consumer demand has on revenue and how price changes can inform their policy decisions. This information can inform policy makers with changes in their rate structures as a way to implement the changes that are being considered for both conservation and revenue management.

Lack of consumer knowledge regarding conservation methods, techniques, and needs results in decreased rates of adoption of conservation methods according to Suh, Khachatryan, Rihn, and Dukes (2017) in a study relating knowledge and perceptions in sustainable water management. Environmental concerns, monetary factors, and household demographics are the

main factors contributing to the purchase and adoption of water conservation methods (Suh, et al., 2017). Education of the public is needed to gain support and understanding of conservation efforts and strategies (Marrin, 2016). Water districts could use their understanding of consumer knowledge and preference to structure policy that promotes water conservation through education campaigns and rate structure adoption. Water districts need to understand the factors that are driving local irrigation techniques and use that information to better educate the consumers towards conservation methods. Policy and education of the public surrounding proposed changes due to conservation efforts are needed on a local level and should focus on the local benefits that are directly related to the consumers.

### **Inequalities in Water Quality and Accessibility**

The effects of water demand fluctuation on fair pricing structures for domestic end users and the aging infrastructure of water delivery systems in the United States is presenting many communities with maintenance costs that exceed what consumers can afford, according to research by Butts & Gasteyer (2011) in a study evaluating water rate structure and inequality. Inequalities in water quality and accessibility can arise from systems that are financially unsustainable. Because water is necessary for life, it presents itself differently than other consumable products in the United States (Butts & Gasteyer, 2011). Water quality and accessibility are variable and rural areas being served by public water systems are often unable to maximize financial economy based on their relatively small size and low population density (Butts & Gasteyer, 2011). Often the costs of maintaining aging water systems are passed disproportionately on to the consumers, further making access to water unequal for certain groups

(Butts & Gasteyer, 2011). Costs of water can depend on multiple factors including quality of water from source, distance from source to consumer, and geographic variations (Butts & Gasteyer, 2011). Programs are needed to evaluate and address service accessibility and affordability (Butts & Gasteyer, 2011). The relationships between structural inequalities and water rate structure needs to be presented in a generalizable way to inform policy and program development (Butts & Gasteyer, 2011). Furthermore, the research done by Sugg (2018) allowed for the argument that during drought conditions, there is a need for a system that prioritizes the allocation of water equitably, especially in highly variable climatic conditions as seen in California. A system such as this will require strong leadership to implement. Determining water accessibility and affordability for consumers would allow analysis of equity in the system and help to inform policy to further ensure equity and sustainability.

### **Water and Energy Conservation**

Water use in California is linked with energy use in production of goods and therefore linked to greenhouse gas emissions. California is already subject to severe droughts. With climate change and increasing demands on water resources, conservation strategies should be employed according to a study by Sokolow, Godwin, and Cole (2016). Water districts have the opportunity to decrease water consumption at the local level. If they couple that decrease with secondary benefits to human and environmental health through decreased greenhouse gas emissions, they will contribute to an overall decreased demand for the state's water supply (Sokolow, Godwin, & Cole, 2016). Energy use may be in part, a result of importing water from distant water sources to meet the demands of California consumers (Sokolow, Godwin, & Cole,

2016). Water scarcity is increased by changes in the climate and will further increase the costs of providing this resource, disproportionately impacting certain consumer populations based on economic status (Sokolow, Godwin, & Cole, 2016). California must find a way to move away from imported water sources as a way to decrease vulnerability (Sokolow, Godwin, & Cole, 2016). Incorporation of diverse stakeholders, including public health officials, should become a larger part of the long-term sustainability planning for local water districts. Gaining a better understanding of the health benefits as well as environmental and financial benefits would allow water districts to maximize their revenue, conservation, and sustainability potential within their water planning.

### **Summary**

The literature review presents a variety of gaps in the literature for guidelines to answer the questions of addressing rate structure development and what influences these decisions. California is not only unique because of its size, gross domestic production, and population, but also because of its heavy reliance on surface and groundwater sources. This reliance makes managing water resources during times of stress due to drought and other fluctuations in climate difficult and places the water systems in a vulnerable situation if not managed for the long-term sustainability of the region.

The material presented in the literature were evaluations of a variety of rate structures and policy needs for California. The literature that was focused on California water all shared in common elements of the complexities of the water management system based upon the diversity in both geography and climate. The diversity of the available water resources makes

management of each region unique. The uniqueness of each region has revealed the need for each water management district to assess their own needs, but to do so in a standard way so that the information collected and disseminated is transparent and accurate as to best inform policy that will contribute to the overall sustainability of the system. While not all of the gaps found during the literature review will be addressed by this study, the literature review did reveal many overlaps and complexities in water management and the need for each local resource district to individually evaluate these complexities as a way to best inform their water management policies.

There exists identifiable rate structures and policies that contribute to the conservation of water and therefore increase the overall water supply long-term as water demand per capita decreases. Water is a basic necessity and having access to a reliable and sustainable system is a continuing concern for water managers. Policy development in this area should incorporate as much local data as possible so that rate structures and conservation programs alike can contribute to financial and environmental sustainability of this critical resource.

## **CHAPTER 3: METHODOLOGY**

### **Introduction**

The research data produced in this study is used to better understand the roles water demands and rate structure plays in conservation actions coupled with sustainable revenue for local water districts. The intent is to provide relevant information to guide policy in the region of Amador County, California. This area is situated at the base of the Sierra Nevada Foothills of Northern California and is unique in its hydrology as compared to the larger region of the state. Therefore, it warrants its own study to determine the best way to proceed for long-term rate structures for water agencies tasked with supplying water in varying conditions as well as to a diversity of locations. While much research has been done in regards to both rate structure applications and water demand, there was a need to more specifically apply these concepts to the unique region of Amador County. There are many factors that influence change within any system and can include politics, geology, hydrology, and climate of the region, changing environmental factors that influence drought cycles, growing population and demand on the water system. State and federal laws regulating the use and fees associated with water distribution, and even leadership styles and the ability to motivate others toward change can influence these systems. All of this encourages or inhibits change at all levels. The data from this study is used to understand what system rate structure best supports both conservation efforts and agency revenue in regards to long-term sustainability through data analysis of variable conditions, to include pre-drought, drought, and post-drought water demand and revenue

associated with rate structures implemented by the local agencies. The questions that were focused on in the research were:

- 1) Is there a measurable difference in revenue for the differing rate structures of tiered and consumption based fixed rate between the water consumption periods of pre-drought, drought, and post-drought?
- 2) Does the revenue remain more stable for the agency under a particular rate structure?

The related hypotheses for the research questions are as follows:

- H1<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the pre-drought period.
- H1 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the pre-drought period.
- H2<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the drought period.
- H2 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the drought period.
- H3<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the post-drought period.
- H3 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the post-drought period.

The quantitative research methodology includes the use of water consumption

data (see appendix C for water consumption data) selected randomly from the Amador Water Agency during three time periods to include pre-drought, drought stage conservation, and post-drought conditions. The water consumption was compared to water rate structures that were used by the agency and those that suggest a greater promotion of conservation while maintaining revenue for the agency (Spang et al., 2015).

The goal is to provide guidance to the agencies so that they are able to make long-term adjustments given the variable climatic conditions to which California is increasingly subject and to avoid the reactionary behavior that often occurs during major changes such as mandatory water use reduction. Research methodology and data analysis will be described in this chapter along with the limitations and delimitations for the study.

### **Research Method**

A quantitative methodology was used to research the problem of the loss of revenue reduction to local water agencies when conservation efforts are implemented and to compare current tiered rates to a consumption based model that may be predictive of increased sustainability for the agencies in terms of revenue and conservation, fitting the unique water demands of rural California. The population size of the local water agencies is approximately 10,000 people. The research design is casual-comparative in nature focusing on between-group comparisons of pre-existing groups, based on the information analyzed, being useful in giving a detailed account of how factors of conservation can affect revenue and what rate structures would be best for implementation by the local water district to maintain a stable revenue. The study included single stage sampling of the randomly selected water users for Amador Water

Agency and included data from pre-drought, during drought conservation measures and post-conservation rates. The data from the three water use periods for a specific time period was analyzed for consumption costs and therefore agency revenue. A quantitative research approach was selected for the study based on having both clear independent and dependent variables and being able to examine the relationship between them as described in the fundamental text on research design by Creswell (2018). The variables were measured for each time period in terms of consumption rates and then the numeric data was analyzed using statistical analysis (Creswell, 2018). The independent variable being the drought time periods and the dependent variable being water consumption rates. Qualitative research is appropriate for trying to understand the meaning social groups apply to a particular problem or situation (Creswell, 2018). A mixed method research approach combines both quantitative and qualitative research along with applicable philosophical assumptions for the study (Creswell, 2018). This research was concerned only with determining if there was a difference in water consumption rates during different drought conditions and how particular water rate structures may affect the revenue of the agency under similar conditions. Since this research was not concerned with why the consumption was different under different conditions or how the consumers viewed the different conditions both qualitative and mixed-methods approaches were ruled out. The questions that this research sought to answer were:

1. Is there a measurable difference in revenue for the differing rate structures of tiered and consumption based fixed rate between the water consumption periods of pre-drought, drought, and post-drought?

2. Does the revenue remain more stable for the water agency using a particular rate structure?

### **Hypotheses**

- H1<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the pre-drought period.
- H1 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the pre-drought period.
- H2<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the drought period.
- H2 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the drought period.
- H3<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the post-drought period.
- H3 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the post-drought period.

### **Research Design**

Methods for calculating agency costs are well established in the field by the American Water Works Association (AWWA) (Spang et al., 2015) and can be used to verify and further support published projections by the Amador Water Agency. Total water demand for single family water users of the agency during the period of 2007-2017 was evaluated. The single-family user group accounts for a large number of the water users in Amador County, with

roughly 7,000 municipal connections, this group has been a significant focus of recent literature in terms of conservation efforts in the state of California. Current increasing block rate structures that are being used by the local agency were discussed in comparison to other proposed rate structures in the water resource field to highlight the variation of choices that are possible. Water demand costs for randomly selected, single-family user groups were evaluated to include the California state mandated percentage decreases in water use during the most recent drought period. Alongside the type of conservation measures that were implemented by the agency over the ten-year period of time for the given data set, the research was given a depth of understanding for the impact conservation has on water demand, as well as to better understand the implications for future use.

Conservation measures include both hardware conservation programs, such as rebates for installation of low flow toilets and shower heads, as well as non-hardware conservation, which is the assumed water savings due to consumer behaviors, such as taking shorter showers (Ashoori, Dzombak, and Small, 2016). The Amador Water Agency published a conservation plan in 2010 that includes conservation policies and program goals. Some of the goals in the conservation plan include retrofitting hardware to increase water use efficiencies, leak detection services, metering of all users, and public education programs (RMC Water and Environment, 2010). The data set was ordered and the rate periods are close to even in terms of intervals. The intervals, while not numerically equal in separation, were equalized by period of time between the water demand situations of pre-drought, drought, and post-drought. In addition to these three levels of use, water use revenue was calculated in the current AWA rate structure for each time period, as

well as a consumption-based fixed rate structure, to attempt to show a significant difference in revenue sustainability coupled with the conservation of water resources. It is the fiduciary responsibility of the resource agency to maintain an alignment between the variable portions of costs and revenue when dealing with the challenges of conservation and traditional increasing block rate structures, which can work to decrease revenue in times of decreased use (Spang et al., 2015). A consumption-based fixed rate (CBFR) structure achieves alignment of the continuous fixed and variable costs associated with operating a water system. It provides water to consumers by dividing the revenue categories into three categories to include: fixed-fixed, fixed-volumetric, and variable which translates to giving the consumer more control over their costs because two of the three categories are tied directly to consumption (Spang et al., 2015). This type of harmonized rate structure attempts to match the fixed and variable costs of water operations, which are typically 80% and 20%, to the fixed and variable charges (Spang et al., 2015). A Consumption-Based Fixed Rate (CBFR) Model is used to show the potential maintenance of revenue stability in the face of conservation tradeoffs in revenue under the more standard Block-Rate structures that are modeled after an assumed 80% for fixed costs and 20% for variable costs for the water agency. Fixed costs are those costs that remain the same for monthly or annual operations regardless of the volume of water sold, such as maintenance of facilities, debt repayments, and operation of facilities (AWWA, 2017). Variable costs for the agencies are associated directly with the volume of water delivered to consumers and include water treatment chemicals and pumping costs due to electrical use (AWWA, 2017). As the volume of water delivered increases, so does the costs in this category, therefore posing the most potential

fluctuations in the cost projections for budgeting. During times of conservation these variable costs may decrease based on the decreased amount of water needing to be delivered along with the revenue received for the product. However, the costs to maintain the fixed portion of the operating costs will remain the same and the potential for revenue instability increases.

Historically, water utilities have placed too much reliance on variable revenue to make up the costs of all areas of operation, both fixed and variable (Spang et al., 2015).

In this study the researcher examined the potential for water savings along with the maintenance of revenue stability by comparing the revenue potential for both the traditionally used block rate structure to that of the consumption-based fixed rate model. As the data set covered three different time periods in which there was a change in consumer water demand based on state drought conditions, the data was used to forecast the effect of a change to the rate structure using paired sample t-tests as the statistical analysis method to show any statistically significant differences in water consumption. Therefore, the research compared agency revenue using the traditional rate structure to that of a consumption-based fixed rate structure. To determine the minimum number of participants, Power Calculator was used with the parameters of a 0.5 effect size, of a 0.05 significance level, and of a power calculation of 0.80 which is recommended to help ensure that a Type II error does not occur or to increase the likelihood that the null hypothesis will be rejected. A paired sample t-test was chosen as the method of statistical analysis based on the data being paired by the traditionally used rate structure and that of the proposed alternative of consumption-based fixed rate. A t-test allows for the comparison of a sample mean to that of the hypothesized mean. A paired sample t-test was conducted to

determine whether a statistically significant difference in revenue was observed for each study period (see Tables 4, 5, and 6). Agency revenue was calculated for each time period and analyzed by the study for both the currently used rate structure and the consumption-based fixed rate model. This information can then be applied by management to the percentage of agency revenue structure that is reliant on variable costs associated with the sale of water to inform water managers in implementing new rate structures or continuing the use of the traditional rate structure.

### **Sources of Information**

The paired sample t-tests were done using the Statistical Package for the Social Sciences (SPSS) software in this study. The SPSS software allows for the investigation of the relationships between variables and for the prediction of possible outcomes of the collected information and data. Paired sample t-tests were chosen as the statistical analysis method because of the ability to compare revenue means under two different conditions within the same group of water users. The water consumption information was sourced from the publicly operated governmental agency of Amador Water Agency to include water demands for a period of ten years including years of significant drought coinciding with state mandated water reductions by user class. This data was analyzed for differences in water consumption rates under the traditional rate structure and then compared to an alternative structure to determine if a difference existed between water consumption and revenue stability for the organization.

## **Participants**

Random sampling of data and number assignment of water users was done through the Amador Water Agency, which is in Amador County, California and serves nearly 14,000 customers through approximately 7,000 residential connections (AWA, 2015). Data collection was primarily from the Amador Water Agency and included rate structure, pricing tiers and water demand totals by year for single-family users. The current rate structure was used to calculate agency revenue for each time period and then compared to those same water consumption rates within the consumption-based fixed rate model. Those outcomes were analyzed for statistically significant differences using paired sample t-tests. Using a minimum power of .80 the minimum sample size for the study was 16.710. The minimum sample size was obtained using the Power Calculator developed by QFAB Bioinformatics. No identifying markers were used for water consumers. They are further grouped by user classification to obtain average use information, so there is little to no risk to the consumers in the data collection and modeling.

## **Data Analysis and Data Sources**

The data needed was collected from the Amador Water Agency which functions as a public utility serving Amador County in order to calculate the differences in water use include using the years 2010 (pre-drought), 2015(drought), 2018(post-drought):

- 1) Variable costs for 25 randomly selected single-family users over the three time periods of pre-drought, drought, and post-drought.

- 2) Amador Water Agency charges under their previously calculated charges following the tiered rate structure for the 25 randomly selected consumers
- a. This data will be in annual format for the periods of pre-drought 2010, drought 2015, and post-drought 2018.
  - b. The data periods were selected for periods of either no water use restrictions, mandated restrictions, and a period following restrictions in the state.
- 3) Total water use for the system for each time period in the study.

The 25 randomly selected single-family users were averaged to find a mean by which further calculations were performed. Calculations of revenue for consumption-based fixed rate were done using the following three-part equation:

$$(1) \text{ FF charge} = \frac{FF}{X} = \$$$

$$(2) \text{ FV charge} = FV \times \frac{A}{W} = \$$$

$$(3) \text{ VC} = VC \times \frac{A}{W} = \$$$

FF = fixed-fixed portion of the water bill

FV = fixed-volumetric portion of the bill

VC = variable portion of bill based on volume used

VC = total variable costs for the yearly mean of the 25 customers

X = total number of customers served during specific time period of analysis

W = total amount of water used by all customers for the year

A = mean amount of water used by the 25-customer group

## **Data Analysis Procedures**

### **Data Analysis**

The paired sample t-tests were done using the Statistical Package for the Social Sciences (SPSS) software in this study. The SPSS software allowed for the investigation of the relationships between variables and for the prediction of possible outcomes of the collected information and data. Paired sample t-tests were chosen as the statistical analysis method because the same set of participants were observed under two different rate structures. The current rate structure was used to calculate agency revenue for each time period based on the water consumption rates from the randomly selected participant group and then compared to those same water consumption rates within the consumption-based fixed rate model. The residential water consumption for the differences in revenue for the agency under different rate structures during drought periods was input into the SPSS software to analyze the collected data using paired sample t-test to determine if the mean calculated differences were statistically significant and allowed the researcher to retain or reject the hypotheses. The calculated revenue based on the traditional rate structure was compared to that of the consumption-based fixed rate structure to help inform leaders of any potential for revenue stability during a variety of consumption periods.

### **Limitations**

By grouping consumers and creating an average use data set, the study loses the ability to evaluate individual user water consumption behavior based on the level of conservation during a certain period of time. The consumers being grouped by time period assumes that their behavior,

and therefore their water consumption, changed based on either the lack of mandated water consumption reduction in the data period of 2007-2014 or a presence of mandated water reduction during the data period of 2015-2017. In the spring of 2017, the state mandated water reduction was lifted and followed by an introduction of legislation to permanently restrict the consumption of water by residential users in the state of California. There is the possibility that behavior and reduction of water during the 2015-2017 mandated water reduction continued beyond this drought period without the influence of the state law and may have impacts on the data for the study. The loss of the ability to analyze each consumer's water consumption also removes the possibility of eliminating consumers on the very high and lows ends of consumption, therefore creating the potential for skewed data. Additionally, by projecting a revenue comparison using a model rate structure such as CBFR, there can be a model produced based on average historical use. However, many other factors of consumer behavior for the area have yet to be evaluated in terms of information relevant to policy development, making it difficult to predict the effectiveness of such a change to rate structures. There are several other much smaller water providers in Amador County which use significantly different rate structures and were not used in this study based on those significant differences. Amador Water Agency single-family users were chosen for the study because they comprise the largest user set for the area and give the study the potential to influence a large user group. During the California state of emergency drought period of 2015-2017, a required reduction in water use of 25% was put in place. The Amador Water Agency repeatedly downplayed the need for conservation and cited less than 10 residents for non-compliance according to their records (AWA, 2017). This lack of

promotion of conservation may have had an effect on the actual amount of water conserved by AWA consumers. Within a district that strictly enforced reductions there may have been an even greater difference in the water demand between periods of the study than those seen in this study.

### **Summary**

The uniqueness of the geography and hydrology of the Sierra Nevada Foothills region and the ever-increasing concern over water conservation highlights the need for water management organizations to specifically study their own rate structure and revenue balance to ensure that state mandated conservation requirements are met along with the maintenance of revenue stability. The research method that was used is quantitative in design and used a one-way repeated measures analysis of variance to determine if there was a statistically significant difference in the water consumption rates among the drought periods. By analyzing the water consumption rates during different water consumption time periods and then comparing the revenue recorded by the Amador Water Agency to that of potential revenue under a consumption-based rate model, using a paired sample t-test method for statistical significance determination, organizational leaders may be better informed to propose changes to the rate structure model in order to further secure long-term revenue stability along with promoting water conservation.

## CHAPTER 4: RESULTS

### Introduction

The purpose of this study was to identify data supported water rate structures that would promote sustainable agency revenue along with water conservation policy for long-term benefits to consumers and water agencies of Amador County in the face of increasing water scarcity. The research draws on consumption data for years that represented a pre-drought period, a drought period, and a post-drought period in order to compare water consumption rates as well as agency revenue during these different time periods. California has highly varied topography and hydrological systems making it necessary for each water resource agency to have a detailed understanding of the natural and human infrastructure systems that impact access to water. The variability in water resources in the state and the history of severe drought periods necessitates that attention be paid to resource planning in the area of Amador County, California. The questions that guided the research are: 1) Is there a measurable difference in revenue for the differing rate structures of tiered and consumption based fixed rate between the water consumption periods of pre-drought, drought, and post-drought? 2) Does the revenue remain more stable for the water agency using a particular rate structure? The hypotheses that were addressed in the research are as follows:

- H1<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the pre-drought period.
- H1 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the pre-drought period.

- H2<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the drought period.
- H2 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the drought period.
- H3<sub>0</sub> There is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the post-drought period.
- H3 There is a significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the agency for the post-drought period.

The purpose of analyzing any possible differences in revenue for the traditional rate structures used by the Amador Water Agency and the consumption-based fixed rate structure was to determine if the observed differences in revenue were statistically significant.

Data was collected through the Amador Water Agency using random sampling methods to obtain water consumption data for 25 continuous user accounts for the research periods of 2010, 2015, and 2018. The water consumption data coupled with the rate structure and fees for the research periods were calculated and then recalculated using a consumption-based fixed rate model (Spang et al., 2015). The residential water consumption for the hypothesized differences in drought periods was input into the SPSS software to analyze the collected data using a paired sample t-test to determine if the calculated differences were statistically significant and would allow for the retention or rejection of the research hypotheses. The calculated revenue based on the traditional tiered block rate structure was then compared to that of the consumption-based

fixed rate structure to determine if there was a statistically significant difference in revenue under the different rate structures.

## **Presentation of Findings**

### **Amador Water Agency Water Supply**

The first step in the research process was to gather water consumption data for a randomly selected group of water users within the Amador Water Agency servicing district. The only criteria outside of being a customer with AWA is that the service must have been continuous throughout the study period of 2010-2018 to maintain consistency in water use behavior for each account. In addition to the water consumption data set for the 25-user group total water usage for the entire organization was reported to help visualize the overall usage in the system over the study period (see Table 1). The 25 water users are only identified in sequence numerically and they are grouped by year. The system-wide water consumption reported by the Amador Water Agency for the drought study years of 2010, 2015, and 2018 show an increase in the average water consumption per consumer during state mandated drought restrictions of just over 20% and a continued increase of over 4% from 2010 to 2018 (see Table 1). Table 1 shows that the number of connections for Amador Water Agency remained nearly the same, yet consumption went up during the study period. This increase in consumption could bring into question the level of conservation efforts being made by both the agency and the consumers during the study period. The revenue generated by each customer was calculated first using the Amador Water Agency rate structures that pertained to that year of service. The

potential revenue that would be generated by the consumption-based fixed rate structure was calculated using formula published by a geographically related water district (Spang et al., 2015).

Table 1

*Amador Water Agency System-Wide Water Consumption*

| Year | Residential Connections | Total Residential Consumption (gallons) | Consumption per Customer (gallons) | Percent Change |
|------|-------------------------|---|------------------------------------|----------------|
| 2010 | 6349                    | 1,014,910,000                           | 159,853.52                         |                |
| 2015 | 6348                    | 1,218,607,940                           | 191,967.22                         | +20.09         |
| 2018 | 6861                    | 1,372,194,915                           | 199,999.26                         | +4.18          |

The second step in the data analysis procedure was to preform statistical analyses to determine if normality could be assumed through descriptive statistics including mean, Kurtosis, and skewness. Each data group for years 2010, 2015, and 2018 were analyzed for normality individually before including them in the paired sample t-tests. For example, group 1 (AWA rate costs for year 2010) showed a mean of \$581.62 per customer with a skewness of 1.298, and Kurtosis of 1.776. This data describes the group as general symmetry in the data set while also having a relative lack of outliers in the group. Group 2 (AWA rate costs for year 2015) which was experiencing drought conditions had similar mean in customer cost of \$590.62, but higher skewness of 1.612 and a Kurtosis of 2.698. By looking at the data set for the 25 customers, it is clear that some dramatically decreased their water consumption during the drought of 2015, while others actually increased their usage. This usage difference is likely the reason for the high

Kurtosis and skewness in this analysis. Group 3 (AWA rate costs for year 2018) had a mean cost of \$725.49, a Kurtosis of .157, and a skewness of .840. This group had an overall increase to their annual water costs of \$134.86 over the previous drought period of 2015. The increased cost to the consumers was due to increased rates implemented by AWA which may have been a factor contributing to the average decrease in water consumption among this user group for this time period. Group 1 (consumption-based fixed rate for 2010) had a mean cost for water of \$667.41, a skewness of 1.700, and a Kurtosis of 3.398. Group 2 (consumption-based fixed rate for 2015) was similar to that of the AWA group 2 with a mean cost of \$468.60, a skewness of 1.637, and a Kurtosis of 2.947. While the cost was down on average to each customer there was a wider range of costs across the group for this time period of 2015 than any other time period in the study. Group 3 (consumption-based fixed rate 2018) had a mean cost of \$563.55, a skewness of .980, and a Kurtosis of .463. Since there are multiple potential explanations for the variation in the water usage including lot size, economics, and behavior, it is not unexpected to see a presence of outliers in the data set. Stem-and-leaf plots for the descriptive statistics are presented for revenue between the groups for each rate structure (Figures 1 and 2). Some of the group data show normality with these tests while others do not, as reported for skewness and Kurtosis. This is not an unexpected result based on the possible reasons for variations in consumption in the study set.

Table 2

*Descriptive Statistics for Amador Water Agency Rate Structures by Group/Year*

| <b>Descriptive Statistics</b> |              |                                  |             |            |
|-------------------------------|--------------|----------------------------------|-------------|------------|
|                               | group_number |                                  | Statistic   | Std. Error |
| awacustomercost               | 1.00         | Mean                             | \$581.6276  | \$40.22443 |
|                               |              | 95% Confidence Interval for Mean |             |            |
|                               |              | Lower Bound                      | \$498.6085  |            |
|                               |              | Upper Bound                      | \$664.6467  |            |
|                               |              | 5% Trimmed Mean                  | \$564.1936  |            |
|                               |              | Median                           | \$515.1300  |            |
|                               |              | Variance                         | 40450.114   |            |
|                               |              | Std. Deviation                   | \$201.12214 |            |
|                               |              | Minimum                          | \$354.48    |            |
|                               |              | Maximum                          | \$1,140.75  |            |
|                               |              | Range                            | \$786.27    |            |
|                               |              | Interquartile Range              | \$287.13    |            |
|                               |              | Skewness                         | 1.298       | .464       |
|                               |              | Kurtosis                         | 1.776       | .902       |
|                               | 2.00         | Mean                             | \$590.6204  | \$45.03065 |
|                               |              | 95% Confidence Interval for Mean |             |            |
|                               |              | Lower Bound                      | \$497.6817  |            |
|                               |              | Upper Bound                      | \$683.5591  |            |
|                               |              | 5% Trimmed Mean                  | \$567.4173  |            |
|                               |              | Median                           | \$534.8200  |            |
|                               |              | Variance                         | 50693.976   |            |
|                               |              | Std. Deviation                   | \$225.15323 |            |
|                               |              | Minimum                          | \$371.46    |            |
| Maximum                       |              | \$1,291.47                       |             |            |
| Range                         |              | \$920.01                         |             |            |
| Interquartile Range           |              | \$249.87                         |             |            |
| Skewness                      |              | 1.612                            | .464        |            |
| Kurtosis                      |              | 2.698                            | .902        |            |
| 3.00                          | Mean         | \$725.4848                       | \$43.85622  |            |
|                               | Lower Bound  | \$634.9700                       |             |            |

|                                  |             |             |      |
|----------------------------------|-------------|-------------|------|
| 95% Confidence Interval for Mean | Upper Bound | \$815.9996  |      |
| 5% Trimmed Mean                  |             | \$711.2840  |      |
| Median                           |             | \$664.6800  |      |
| Variance                         |             | 48084.211   |      |
| Std. Deviation                   |             | \$219.28112 |      |
| Minimum                          |             | \$454.84    |      |
| Maximum                          |             | \$1,277.12  |      |
| Range                            |             | \$822.28    |      |
| Interquartile Range              |             | \$356.24    |      |
| Skewness                         |             | .840        | .464 |
| Kurtosis                         |             | .157        | .902 |

Notes. Group 1 = year 2010, Group 2 = year 2015, Group 3 = year 2018.

Abbreviations: awacustomercost = Amador Water Agency customer cost

Table 3

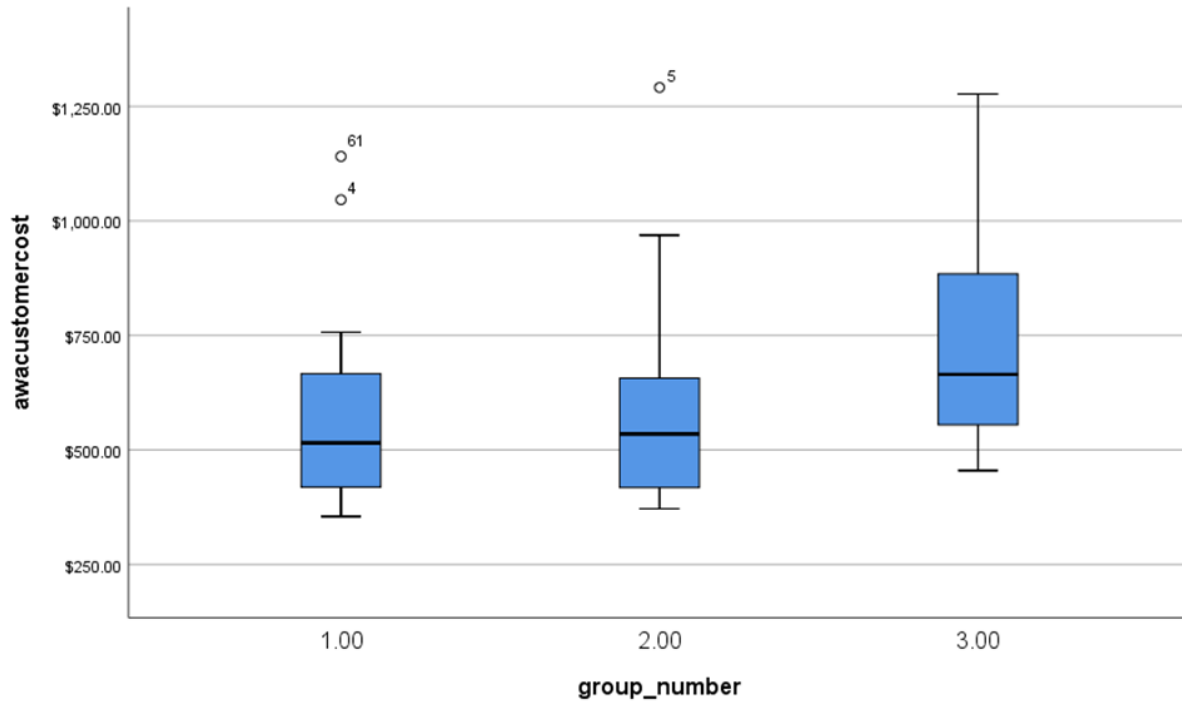
*Descriptive Statistics for Consumption-Based Fixed Rate Structure by Group/Year*

|                                  |              | <b>Descriptives</b>              |             |             |            |
|----------------------------------|--------------|----------------------------------|-------------|-------------|------------|
|                                  | group_number |                                  | Statistic   | Std. Error  |            |
| cbfrcustomercost                 | 1.00         | Mean                             | \$667.4136  | \$89.74487  |            |
|                                  |              | 95% Confidence Interval for Mean | Lower Bound | \$482.1893  |            |
|                                  |              |                                  | Upper Bound | \$852.6379  |            |
|                                  |              | 5% Trimmed Mean                  |             | \$619.0991  |            |
|                                  |              | Median                           |             | \$563.7600  |            |
|                                  |              | Variance                         |             | 201353.559  |            |
|                                  |              | Std. Deviation                   |             | \$448.72437 |            |
|                                  |              | Minimum                          |             | \$209.76    |            |
|                                  |              | Maximum                          |             | \$2,078.02  |            |
|                                  |              | Range                            |             | \$1,868.26  |            |
|                                  |              | Interquartile Range              |             | \$554.61    |            |
|                                  |              | Skewness                         |             | 1.700       | .464       |
|                                  |              | Kurtosis                         |             | 3.398       | .902       |
|                                  |              |                                  | 2.00        | Mean        | \$468.6040 |
| 95% Confidence Interval for Mean | Lower Bound  |                                  |             | \$345.2700  |            |
|                                  | Upper Bound  |                                  |             | \$591.9380  |            |
| 5% Trimmed Mean                  |              |                                  |             | \$436.8616  |            |
| Median                           |              |                                  |             | \$387.5600  |            |
| Variance                         |              |                                  |             | 89274.823   |            |
| Std. Deviation                   |              |                                  |             | \$298.78893 |            |
| Minimum                          |              |                                  |             | \$191.36    |            |
| Maximum                          |              |                                  |             | \$1,415.04  |            |
| Range                            |              |                                  |             | \$1,223.68  |            |
| Interquartile Range              |              |                                  |             | \$331.90    |            |
| Skewness                         |              |                                  |             | 1.637       | .464       |
| Kurtosis                         |              |                                  |             | 2.947       | .902       |
|                                  | 3.00         |                                  |             | Mean        | \$563.5504 |
|                                  |              |                                  | Lower Bound | \$424.1371  |            |

|                                  |             |             |      |
|----------------------------------|-------------|-------------|------|
| 95% Confidence Interval for Mean | Upper Bound | \$702.9637  |      |
| 5% Trimmed Mean                  |             | \$538.3873  |      |
| Median                           |             | \$477.6600  |      |
| Variance                         |             | 114070.034  |      |
| Std. Deviation                   |             | \$337.74256 |      |
| Minimum                          |             | \$177.26    |      |
| Maximum                          |             | \$1,450.12  |      |
| Range                            |             | \$1,272.86  |      |
| Interquartile Range              |             | \$544.12    |      |
| Skewness                         |             | .980        | .464 |
| Kurtosis                         |             | .463        | .902 |

Notes. Group 1 = year 2010, Group 2 = year 2015, Group 3 = year 2018.

cbfrcustomercost= consumption-based fixed rate cost

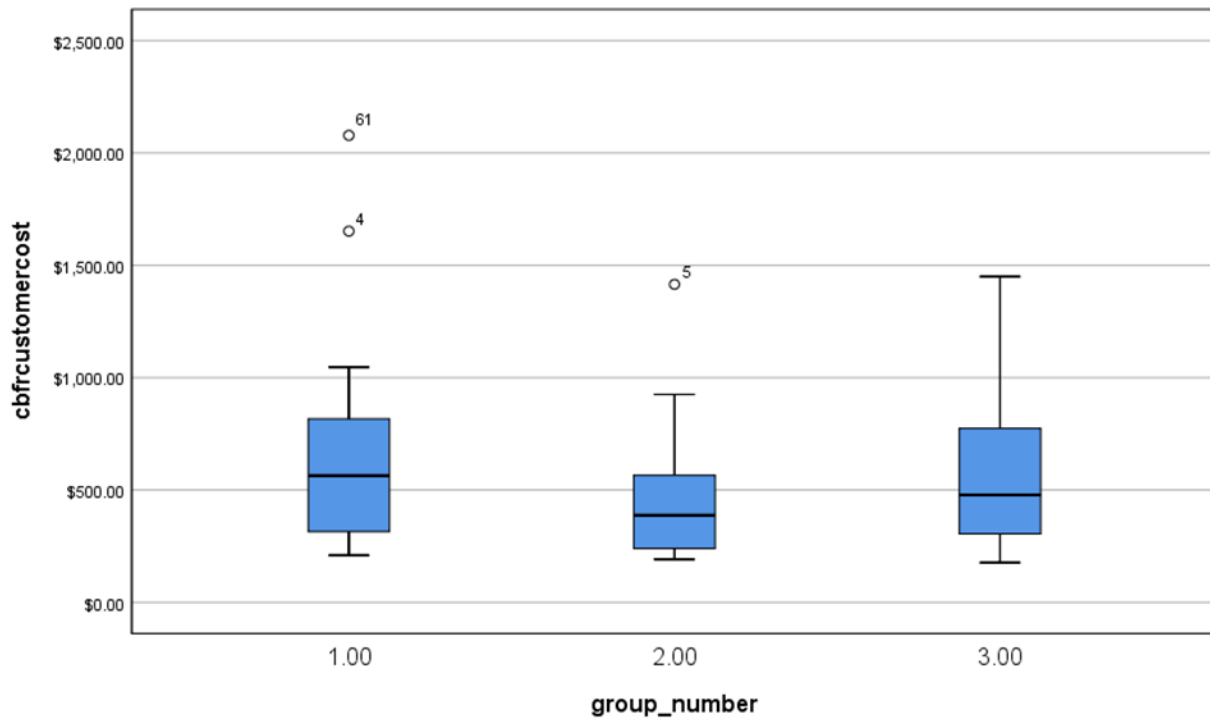


Note: awacustomercost = Amador Water Agency rate cost

Note: group 1 = 2010, group 2 = 2015, group 3 = 2018

*Figure 1.* Stem-and-Leaf Plot for Amador Water Agency traditional rate structure

This plot shows a range of water consumption costs with the greatest cost and variability in range for the year 2018.



Note: cbfrcustomer cost = consumption-based fixed rate cost

Note: group 1 = 2010, group 2 = 2015, group 3 = 2018

*Figure 2.* Stem-and-Leaf Plot for consumption-based fixed rate structure

This plot shows a range of customer costs in all study periods with the widest range seen in the data for the pre-drought period of 2010.

### Paired Samples T-Tests

A paired samples t-test was performed for the drought periods of the study comparing the AWA mean revenue to the revenue that would be obtained using the CBF rate structure. A t-value produced by this analysis allows the data in the study to be compared to that of what is expected under the null hypothesis. A t-value of zero would indicate that the results in the study are exactly equal to the null hypothesis and anything other than zero can be used to determine if the data in the study was unusual enough to reject the null hypothesis. The p-value produced in a

paired samples t-test evaluates how well the sample data supports the null hypothesis being true. Having a high p-value indicates that the study data obtained are likely true with a null hypothesis and low p-value indicates the study data obtained are unlikely with a true null hypothesis and suggests that the sample provides enough evidence to reject the null hypothesis.

Table 4

*Paired Samples Test Comparing the Mean Customer Revenue for Amador Water Agency to a Consumption-Based Fixed Rate for 2010*

| Pair |            | Mean      | Std. Deviation | Paired Differences |   | t          | df     | Sig. (2-tailed) |      |
|------|------------|-----------|----------------|--------------------|---|------------|--------|-----------------|------|
|      |            |           |                | Std. Error Mean    | 95% Confidence Interval of the Difference |            |        |                 |      |
|      |            |           |                | Mean               | Lower                                     | Upper      |        |                 |      |
| 1    | AWA - CBFR | -\$85.786 | \$251.7532     | \$50.35065         | -\$189.7046                               | \$18.13264 | -1.704 | 24              | .101 |

Note: AWA=Amador Water Agency, CBFR=consumption-based fixed rate

There was an \$85.79 mean difference in revenue for this pre-drought period and shows a potential for increased revenue for the agency using the consumption-based fixed rate model. In the t-test comparison of the 2010 AWA revenue to that of revenue under the CBFR model a p-value of .101 was calculated. The value of .101 is greater than .05 and does not allow for the rejection of the null hypothesis that there is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the pre-drought period.

Table 5

*Paired Samples Test Comparing the Mean Customer Revenue for Amador Water Agency to a Consumption-Based Fixed Rate for 2015*

| Pair         | Mean      | Std. Deviation | Std. Error Mean | Paired Differences |            | t     | df | Sig. (2-tailed) |
|--------------|-----------|----------------|-----------------|--------------------|------------|-------|----|-----------------|
|              |           |                |                 | Lower              | Upper      |       |    |                 |
| 1 AWA - CBFR | \$122.016 | \$76.54462     | \$15.30892      | \$90.42033         | \$153.6124 | 7.970 | 24 | .000            |

Note: AWA=Amador Water Agency, CBFR=consumption-based fixed rate

There was an \$122.02 mean difference in revenue for this drought period and shows a potential for decreased revenue for the agency using the consumption-based fixed rate model. In the t-test comparison of the 2015 AWA revenue to that of revenue under the CBFR model a p-value of .000 was calculated. The value of .000 is less than .05 and does allow for the rejection of the null hypothesis that there is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the drought period.

Table 6

*Paired Samples Test Comparing the Mean Customer Revenue for Amador Water Agency to a Consumption-Based Fixed Rate for 2018*

|                   | Mean       | Std. Deviation | Paired Differences |  | t     | df | Sig. (2-tailed) |
|-------------------|------------|----------------|--------------------|--|-------|----|-----------------|
|                   |            |                | Std. Error Mean    | 95% Confidence Interval of the Difference<br>Lower Upper |       |    |                 |
| Pair 1 AWA - CBFR | \$161.9344 | \$122.48257    | \$24.49651         | \$111.37608 \$212.49272                                  | 6.611 | 24 | .000            |

There was an \$161.93 mean difference in revenue for this post-drought period and shows a potential for decreased revenue for the agency using the consumption-based fixed rate model. In the t-test comparison of the 2018 AWA revenue to that of revenue under the CBFR model a p-value of .000 was calculated. The value of .000 is less than .05 and does allow for the rejection of the null hypothesis that there is no significant difference in revenue between the tiered rate structure and the consumption-based fixed rate structure for the post-drought period.

### Summary

The Amador Water Agency has historically used either a tiered water rate structure that increases consumer costs as more water is consumed or used a flat rate for all consumption rates.

These rate structures tend to favor either conservation of water or increased revenue, but not both variables simultaneously. A consumption-based fixed rate structure accounts for both conservation of water and the need for organizations to have steady revenue. This alternative rate structure was used to calculate the potential revenue for the Amador Water Agency for the pre-drought, drought, and post-drought periods and to analyze for statistically significant differences between traditional rate structure and CBFR.

The data set of 25 water consumers was larger than the minimum of 16 calculated by Power Calculator. These data sets were carefully tested for normality using descriptive statistics and the normality tests of skewness and Kurtosis before proceeding with the paired sample t-tests. There were extreme differences in water consumption among the consumer groups likely contributing to these normality results.

The null hypothesis for the 2010 pre-drought period was retained based on the paired sample t-test p-value of 0.101 being greater than 0.05. This high p-value indicates that the data in this sample are statistically likely with a true null hypothesis. The null hypothesis for the 2015 drought period was rejected based on the paired sample t-test p-value of 0.000 being lower than the accepted value of 0.05. This low p-value indicates that the data in the sample is unlikely with a true null hypothesis and suggests that the sample provides enough evidence to reject the null hypothesis. There is a mean difference in revenue \$122.02 which indicates a potential decrease in revenue to the agency if they implemented the CBFR rate structure at the calculated 2010 rates. However, if CBFR rates were increased in proportion to the rate increases implemented by the agency using the tiered or flat rate structures, there may be a potential for revenue increases

especially to those high-volume water consumers. The null hypothesis for the 2018 post-drought period was rejected based on the paired sample t-test p-value of 0.000 being lower than the accepted value of 0.05. This low p-value indicates that the data in the sample is unlikely with a true null hypothesis and suggests that the sample provides enough evidence to reject the null hypothesis. There is a mean difference in revenue \$161.93 which indicates a potential decrease in revenue to the agency if they implemented the CBFR rate structure at the calculated 2010 rates. Again, if CBFR rates were increased in proportion to the rate increases implemented by the agency using the tiered or flat rate structures, there may be a potential for revenue increases especially to those high-volume water consumers.

Further explanation and discussion are required with normality not being seen across all study groups and the paired sample t-test comparisons not allowing for the rejection of all null hypotheses. There are many factors in water rate structure that contribute to the complexity of comparing an actual and implemented rate structure program to that of a hypothetical one. These results indicate the need for further calculations that may include inflation pricing into the CBFR model and the removal of the AWA mandated drought fee from the calculations for the 2015 data year.

## **CHAPTER 5: CONCLUSIONS AND DISCUSSION**

### **Introduction**

The purpose of this study was to identify data supported water rate structures that would promote sustainable agency revenue along with water conservation policy for long-term benefits to consumers and water agencies of Amador County in the face of increasing water scarcity. The water rate structures that were implemented by AWA during the study period included both a flat rate system with additional drought surcharge fees and a tiered rate structure. These rate structures tend to favor either water conservation or revenue stability, but not the conservation and revenue simultaneously. Water utility organizations often structure fixed and variable costs and revenue in an inversely proportional way and therefore, the two factors are not aligned for the consumer making the prediction of water consumption under variable conditions challenging for the organization (Spang et al., 201). A consumption-based fixed rate structure works to achieve a more harmonized structure by dividing the revenue into three categories: fixed-fixed, fixed-volumetric, and variable (Spang et al., 2015). The fixed-volumetric portion of the billing is divided among the consumers based on their proportional share of the system and at the same time does not punish the consumer for conserving water. A CBFR system should have less of a negative impact on revenue during drought conservation periods, meaning that the revenue would not be expected to fluctuate as much as a traditional structure because it relies less heavily on per unit time water sales. Based on this, the majority of the fluctuation in water use is reflected only in the variability portion of the revenue, a smaller percentage of the revenue calculation than the traditional rate structure, and still allows for the fixed costs of providing

water service to be maintained. The data analysis shows that there is not a statistically significant difference in the revenue possibilities for the Amador Water Agency for the first year of the data analysis, but there is for the remaining years of the study. The mean difference in revenue during the pre-drought period between the AWA rate structure and CBFR was -\$85.79. While the difference was not statistically significant it does show that on average the CBFR rate structure would provide a slightly higher revenue on average for the agency. There are many factors that contribute to both consumer behavior, water consumption and how rates are implemented across the organization. The variety of factors that are involved make this a very complex topic to analyze, but, never the less, contributes valuable information for leadership decisions within these types of organizations. During 2015 there was a state mandated drought and reduction in water consumption. Under the agency's traditional tiered structure, this would reduce the consumer's cost and therefore the agency revenue. This reduction in revenue could force an organization to increase water fees or implement additional fees to help make up the loss. Many of the consumers in the data set did in fact reduce their water consumption during the drought period, but under the AWA water rate structure still saw an increase in their monthly bill. This individual reduction in water consumption is in conflict with the reported system-wide consumption for AWA (Table 1), but is important to consider when looking at the individual reduction effort and the resulting increased costs for the following years because of rate increases. The calculated CBFR structure showed that as customers decreased their water use, they also decreased their monthly bill. Since this rate structure is formulated to have revenue fluctuations mainly in the variable cost section, the water utilities cost for supplying should have

been proportional and revenue should remain stable if the CBFR rates were increased in proportion to the actual rate increases implemented by AWA. The implications for leadership are severalfold and include the significant benefit of maintaining revenue stability under the highly variable hydrologic conditions that California experiences. Another very important aspect of the research findings is the evidence of consumer control over their water costs. AWA customers have continuously seen their bills increase over the years, including the period of time that they reduced their water usage. These increases in water costs to consumers that are actively conserving both for environmental and financial reasons can discourage further and long-term reductions. Water organization leadership could use this information to structure rates in a way that encourages conservation and allows the water district to maintain the steady source of revenue on which they depend. The research presented clear differences in the revenue that could be obtained by AWA under different rate structures, but did not reflect in the CBFR structure any increasing costs over time as seen in the AWA rate structure systems. It would be recommended that future research and data analysis include per unit increases to the CBFR model that mirror the increases AWA implemented over the research period to obtain a more accurate comparison of the two models.

The introduction of the CBFR model may cost a consumer more or save them money depending on their individual water consumption behavior. One of the benefits of this rate structure is that it is relatively stable for both the water agency and the consumer compared to that of a traditional structure that realizes the greatest fluctuations in revenue based upon usage.

A CBFR structure would allow both parties to have greater control over the financial aspect of consuming water.

### **Discussion of Findings and Conclusions**

The researcher examined the variables of water consumption during changing drought conditions in the Northern California area of Amador County. Water consumption among the user group was evaluated against both the traditional rate structures being either tiered or flat rate and then against a consumption-based fixed rate model. The research questions for the study were:

1. Is there a measurable difference in revenue for the differing rate structures of tiered and consumption-based fixed rate between the water consumption periods of pre-drought, drought, and post-drought?
2. Does the revenue remain more stable for the water agency using a particular rate structure?

Each period of the study saw a change in the rate structure implemented by AWA with increasing costs to the consumers as the years went by. AWA also initiated a drought surcharge for the later six-month period of 2015 in addition to an increase in the flat rate structure that they had in place for that year. AWA instituted the rate surcharge to supplement their water rate fees during the drought period as demand for water was expected to decrease (AWA, 2015). The price for a unit of water tends to increase as demand for water decreases (Spang et al., 2015). The CBFR structure that was used during the study was modeled after a published rate structure proposal by the City of Davis, California (Spang et al., 2015) and was kept constant throughout

the study. CBFR structures keep costs and revenues aligned and help to reduce the need for water agencies to increase cost as quickly as they would under traditional structures (Spang et al., 2015).

A consumption-based fixed rate structure was chosen as the model for an alternative rate structure based on the ability to support conservation efforts while at the same time sustaining revenue for the providing water utility organization (Spang et al., 2015). The first hypothesis tested was concerned with having a consumption-based fixed rate structure compared to the traditionally used tiered rate structure that would create significant difference in revenue for the water agency during a period of time that was considered pre-drought stage for California. The research along with the statistical analysis did not show a statistically significant difference between the revenue that could be obtained by AWA during this period of time and would not support the adoption of a CBFR structure for revenue purposes under the study conditions. However, a consumption-based rate structure for AWA is still worth considering as both a long-term option for maintaining revenue in a variety of usage conditions and as a way to encourage consumers to conserve this resource since it most costly to those who are demanding the most from the system.

The second hypothesis tested was concerned with having a consumption-based fixed rate structure compared to that of the traditionally used tiered rate structure that would create a significant difference in revenue for the water agency during a period of time that was considered drought stage for California. The research analysis did find a statistically significant difference in the water rate structure data and the null hypothesis was rejected. The rejection of

the null hypothesis is likely due to a variety of factors and it must be considered that in this study, the AWA rates increased yearly and the CBFR model rates were not increased.

The third hypothesis tested was concerned with having a consumption-based fixed rate structure compared to that of the traditionally used tiered rate structure that create a significant difference in revenue for the water agency during a period of time that was considered post-drought stage for California. This null hypothesis was also rejected since the researcher did prove a statistically significant difference in the revenue over this time period.

In examining the water consumption stem-and-leaf plots (Figures 1-2) there is evidence of outlier groups for each case. These outliers impacted the statistical analyses by being included and results in most groups not having a normal distribution. However, the outliers remain in the data set and statistical analysis because they are a reflection of the unevenness of water consumption per customer in the AWA system. Residential connections can vary from single apartment units to large homes that irrigate several acres of land. The variable in the lot size and land use is just one of the factors that provided complexity to this study, but also clarifies the need for a more equitable rate system for AWA.

Adding to the multiple dimensions of evaluating revenue over the research period was the 20% increase in water consumption per connection from 2010 through 2015 even though the number of residential connections remained nearly identical from 6,349 in 2010 to 6,348 in 2015. During the year 2015 the State of California put in place a mandatory reduction in water use of 25% for the entire state based on severe drought conditions. While there was a substantial increase in systemwide water usage from 2010 to 2015, 80% of the study customers reduced

their water usage during this period of time and 25% of those customers reduced their water consumption by 50% or more (see appendix C). This shows an effort among some in this consumer group to change their water use behavior and decrease water usage during the drought while others in the study group increased their water consumption over the study period. However, with the increased water rates and the addition of the surcharge during the 2015 drought year, 60% of the study group consumers saw an increase in their water bills even though 80% had reduced their consumption. This may have helped maintain revenue stability for AWA in the short term, but likely does nothing to encourage consumers to permanently change consumption behavior and conserve water long-term. Furthermore, this increase to their water bills may have had a negative impact on long-term behavior and perception of the utility management. In 2018, after the surcharge was lifted and drought conditions improved, 68% of consumers increased their water consumption over the 2015 levels. The overall system realized an additional 4% in water consumption per connection from 2015 to 2018.

### **Application of Findings and Conclusions to the Problem Statement**

The problem stated in this study is the loss of revenue to local water agencies when conservation measures are implemented. Applying a one-size-fits all rate structure to such a variable customer base, as found in the region of Amador County, does not allow the water agencies to equitably charge customers for the product (Mukherjee, Mika & Gold, 2016). The rate structure that AWA chose to implement during drought conditions did help to maintain revenue among the study group, but at the same time seemingly punished those that were conserving by continuing to increase their water rates. Furthermore, during times of mandatory

conservation, the agencies may be forced to charge customers a fee in addition to their regular rates as an incentive for conservation (Mukherjee, Mika & Gold, 2016). AWA did implement a drought surcharge in 2015. When agencies see a decrease in water usage during conservation, they also realize a loss in revenue unless they approach conservation rate restructuring in a way that targets the heaviest consumers of the resource and not simply all users equally in the system (Mukherjee, Mika & Gold, 2016). This would be reflected in the consumption-based fixed rate structure. One of the key aspects of CBFR is that much of the base cost to the consumer is allocated towards fixed costs for the organization, such as maintenance of water mains, tanks and meters. These are costs that do not tend to fluctuate based on water demand by the consumers. Variable costs associated with the delivery and treatment of certain quantities of water to the consumer are also included in the CBFR model and should be proportional to water demand. In this way CBFR allows the consumers greater control over their water bill as they choose to increase or decrease their consumption while at the same time. By using the fixed base rate charges, the structure may still provide the necessary revenue for the water agency because of how the rate structure is aligned with fixed versus volumetric costs. The CBFR model uses a supply fee as part of the rate calculation which is based on the individual consumer's use during the peak summer months. In doing so consumers that use a greater portion of the system pay a proportionally increased fee for their water usage (Spang et al., 2015). By including this proportionality as part of the water rate revenue, equability is increased across the system.

### **Application to Leadership**

A change in the historical practice of water rate structuring can expect a good deal of resistance from the community that relies on the water provided by AWA. According to Doppelt (2010) resistance to change is a natural and protective mechanism for people when they fear that their control over something is at risk. In this case, the perceived control may be the cost of consuming water. When leaders are trained to have a deep understanding of the organization and the impacts changes may have on the people they serve, they are better equipped to manage each situation that may arise as the organization goes through a transition. To manage situations of change and resistance to that change, leaders need to identify the key points (Doppelt, 2010). The key point from this research is that a rate structure that is designed to mirror both revenue sustainability and conservation, such as CBFR, actually puts the consumer in greater control of their costs than under the traditional rate structures. With this information the leaders of the organization should work to educate and communicate the benefits to the consumer and to the system as a whole.

Leaders in water management should also be aware of the importance of continuous and area-specific data collection and analysis. According to a study done by Sterle and Singletary (2017), continuous data collection contributes to greater collaboration among water managers, improves their understanding of the human dynamics of drought conditions, helps build local capacity to adapt to ongoing drought conditions, and increases communication and coordination among regional water managers. In an article on water management for conservation, Capodaglio, Ghilardi, and Boguniewicz-Zablocka (2016) discussed the importance of tailoring

conservation approaches specifically to the area, the local issues, and conditions because these all vary greatly throughout water management areas.

The management of water systems is described as ever-changing in a paper by Nyamwanza and Kujinga (2016), with the variability in factors including climate change, hydrological information, societal perspectives, economy, and legislation. Sustainable leadership for water resources requires a balancing system focusing on the water that is available, consumer demand, system integrity, and capacity building and maintenance (Nyamwanza & Kujinga, 2016).

Transformational leadership works within the concept of what factors motivate others to change (Northouse, 2018). The right to clean and affordable water is a motivating factor for AWA customers. The managers should understand that the consumers must be a part of the change process before the changes are implemented. By providing structured and organized opportunities for stakeholders to be part of the decision-making process, there is a greater chance of success in the proposed changes. Leaders working to implement organizational change can lead by accomplishing a set of well-defined goals. This style of leadership is described by the path-goal theory (Northouse, 2018) and would require the leaders to understand the importance of affordability and accessibility of water to their consumers before defining the goals of any organizational change process. Finally, the actions between the leaders and those that they are leading, in this case the water consumers, are described by the leader-member exchange theory (Northouse, 2018). The leaders in water management must create a positive environment throughout the system which includes the employees of the organization as well as the

consumers. The creation of high-quality partnerships within the organization can be done by well-informed and motivated leaders who focus on the needs of the entire organization and are able to balance the management of the complex variety of factors involved in managing a natural resource such as water.

### **Recommendations for Action**

These recommendations are specifically designed for the AWA board, managers, and community partners. The research suggests that there is an opportunity for AWA to improve the sustainability of their revenue and support conservation efforts in the community through an alternative rate-structure approach. It would be recommended that more research be done by the agency to identify a rate structure similar to the CBFR used in this study that would align with their long-term needs and help them to avoid reactionary changes to the rate structure system since these increases have traditionally been ill-received by the public. By implementing a rate structure that encourages conservation through decreased costs and also maintaining revenue for fixed costs, a CBFR structure may provide the revenue stability that the agency needs along with supporting consumer relationships through greater control over their individual costs. Strong and well-informed leadership will be a critical function of any organizational change including one that focuses on rate structures. As leaders develop a deeper understanding of water availability into the future and make plans to adjust their management based on this information, it is important that they bring together community partners that will be affected by these changes. Water managers should consider coupling the increasing population of Amador County and the surrounding areas with the climate variability that California is likely to continue to experience

to better plan for a sustainable future. Several strategies for adapting to variable water conditions were identified in a study by Sterle & Singletary (2017) that are pertinent to the management of the AWA system. The strategies include:

- 1) The collection of science-based information
- 2) Increase collaboration and communication

Leaders can support the collection of science-based information and then use that information to inform and support changes to the rate structure that enhance revenue stability and conservation practices. The coordination of local and regional meetings that function to discuss and plan rate changes within the local community can help leaders collaborate and build trust with the consumers as they come to view themselves as a greater part of the organization. People may be more willing to participate in the discussions if they already have a negative view of how water is being managed, according to a study by Jennewein and Jones (2016). Leaders will need to plan for when, how, and where the meetings should take place. A key point person should be identified by the leaders. This person should have the knowledge of the proposed rate changes, and be able to effectively communicate this with the public. A study done by Ramsey, Bergland, and Goyal (2017) publicizing conservation initiatives is a potential way to encourage consumers to change their water consumption behaviors and to help consumers feel that they are part of the change. A plan will be needed by the leaders to educate the public concerning the benefits a rate change will have for them which go beyond the public meeting forums in order to reach as many consumers as possible.

An increased commitment to transparency and communication with the public will help create a culture that is more tolerant and understanding of changes to the rate structure systems, and as leaders work to continuously gather data and educate themselves, the public will understand the needed changes. A study by Megdal et. al (2017) found that stakeholder engagement in the change initiative is a necessary condition for water resources to be managed sustainably and equitably. This culture change can be facilitated through the use of routine meeting platforms that bring together stakeholders of water resources in Amador County (Nyamwanza & Kujinga, 2017). These participatory meetings will not only provide information, but will function to support the legitimacy in the rate changes (Nyamwanza & Kujinga, 2017) as the public better understands their role in the implementation and the increased control they can have over their water use.

Leaders must factor in the variety of aspects that will contribute to the success or failure of a proposed organizational change. The process will require that the organization identifies and supports a leader who understands the process and can effectively communicate with all those affected.

### **Recommendations for Further Research**

Sustainable water resource management is increasingly important as the population continues to grow and the prospect of highly variable climate conditions along with the increased possibility of prolonged drought conditions continue to effect California. Many interesting aspects of water consumption were evident in the study including the overall individual water demand in the AWA system during a drought period when a state-wide, mandatory water

reduction was in place. One surprising finding in the data was that from 2010 to 2015 overall agency water demand increased while the number of water main connections remained about the same. A similar pattern of increase was seen from 2015 to 2018. The most surprising aspect of this data is that during a state mandated drought reduction in water usage the consumer group of Amador Water Agency actually increased their overall usage by just over 20%. At the same time that the AWA was seeing increasing sales of water, their governing board elected to implement water rate surcharges to offset reduced revenue due to decreased water sales (AWA, 2015). There was no information available regarding any implemented strategies by AWA to comply with the state mandated reductions of water consumption. It would be recommended that future research focus on some of the possible reasons for the increase in water consumption seen by AWA customers. Further research into the possible reasons that most influenced consumers decisions as to whether they chose to reduce water consumption or during and after drought periods would be beneficial in understanding the wide variation in consumption seen in the study time periods. Another surprising finding is the increase many consumers saw to their water bills even after reducing their personal consumption, which was due to an increase in water rates and the additional water rate surcharge implemented in 2015. An examination of how the implementation of drought surcharges and increasing water rates effect consumer motivation to conserve could provide greater insight to leaders and inform future rate decisions.

In this study CBFR was not increased over the study period while the AWA rates did increase. A study that uses a similar percentage increase in the CBFR model to that seen in the AWA rate increases may show a greater significance factor in the comparisons of the revenue

under the traditional and CBFR models. While there was a published conservation plan available to the public during the time periods of the study, it is not clear what level of effort went into educating, disseminating, or supporting the details of the plan. Further research of the effort levels of the Amador Water Agency to support their conservation plan may be needed to better understand how aware consumers were of the ways to reduce water consumption, their utility bills, and other conservation factors, such as appliance use and time of day use. This information may help to explain why some consumers reduced water use over the study period while others increased their use and therefore, their costs.

It will be important for water conservation and management research to continue to include studies that are specific in geographical focus in order to include the unique characteristics of each water management utility. Leaders will need accurate assessments of their water needs for growth and financial planning purposes. Water utility managers have an opportunity to use accurate and informative data to drive their conservation plans as well as to help educate the public regarding necessary rate changes and structures.

### **Concluding Statement**

Water is the resource that provides life and the ability for a society and economy to flourish. Proper management of this precious resource cannot continue to be viewed in the short-term. Long-term sustainability should be built into every management system which also includes a more significant role of conservation. Conservation of water resources does not need to create revenue shortfalls and financial deficits for the organizations that manage the treatment and distribution of this resource. Water resource managers should carefully evaluate the needs of

their consumers and apply a more equitable rate structure that rewards those that conserve and has those consumers that demand more pay a portion that is in line to what they are demanding. As the population of Amador County continues to grow and the cost of delivering water continues to increase, it will become more necessary for AWA to plan a fair and direct path to address these challenges to the system. Rate increases are historically received very poorly by the public. Any consideration of changes to the rate structure system requires that a substantial public education campaign should take place to communicate the reasoning and benefits of any such changes. Water is much more than a molecule, it is a life source, a conduit for recreation, nourishment, transportation, and so much more. For these reasons, water managers must continue to study and account for the complexities in their individual systems through water rate structures that strive for equitability and sustainability.

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## Appendix A

Consent Form Amador Water Agency

**CityUniversity****Organizational Informed Consent  
Form**Name of Organization Amador Water Agency

Address 12800 Ridge Rd  
 City, State, Suttere Creek, Ca  
 Zip 95685 1-209-257-524  
 Telephone

By signing this consent form, I understand that **Kelsi Williams** (the researcher) is a candidate for an advanced degree, or a faculty member of City University of Seattle. I understand that the researcher is conducting a study entitled **COUPLING CONSERVATION EFFORTS WITH WATER RATE STRUCTURE: EVIDENCE TO INFORM LEADERSHIP AND SUPPORT POLICY**. The purpose of this research is to **identify any possible variation in revenue for Amador Water Agency under the currently used tiered structure and a consumption-based fixed rate structure and to identify which water rate structure that will support sustainable agency revenue along with water conservation policy to ensure long term benefits to consumers, water agencies and local ecosystems of Amador County.**

I understand the findings of this research study are solely the responsibility of the researcher. It is understood that any and all information/data the researcher collects from contacts within and/or about our organization outside the research protocol will not be part of the research findings. I understand the researcher may publish findings following completion of this study. Any information published will be limited to the findings of the research. No research participants will participate in this study without organization and City University of Seattle Institutional Review Board (IRB) knowledge and approval.

I grant the researcher permission to contact members of the organization for the purpose of requesting participation in the study as required by the research design. I grant the researcher permission to use organizational premises as necessary to conduct the research.

I grant the researcher permission to collect, use, and store organizational documentation related to the project under study. I understand that in granting permission to access organizational documentation, the researcher will store copies in a secure manner outside of the organization in a secure manner as approved by the City University of Seattle IRB.

C&J The researcher will maintain all documentation and findings regarding this organization in confidence and confine its use to this research study.

C&J On behalf of the organization, I request a final copy of this research report.

Date

Print Name and Title Cris Thompson, Assistant General  
Manager Organization Amador Water Agency

Name of Research Supervisor or Advisor: Dr. Sher  
Downing Contact Information Faculty Supervisor: Dr. Sher  
Downing Department: School of Applied Leadership  
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## Appendix B

## SPSS Software Purchase Receipt

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## Appendix C

## Amador Water Agency Water Consumption Data

| customer # | January | February | March | April | May   | June  | July   | August | September | October | November | December | Total for year | CBFR Total |
|------------|---------|----------|-------|-------|-------|-------|--------|--------|-----------|---------|----------|----------|----------------|------------|
| #1-2010    | 2       | 3        | 3     | 3     | 5     | 10    | 17     | 16     | 18        | 17      | 6        | 5        | 105            |            |
| Cost       | 3.78    | 5.67     | 5.67  | 5.67  | 9.45  | 18.9  | 32.13  | 30.24  | 34.02     | 32.13   | 11.34    | 9.45     | 198.45         | 563.76     |
| #1-2015    | 3       | 2        | 2     | 1     | 4     | 7     | 8      | 10     | 10        | 7       | 5        | 3        | 62             |            |
| Cost       | 6.06    | 4.04     | 4.04  | 2.02  | 8.08  | 14.14 | 16.16  | 23     | 23        | 16.1    | 11.5     | 6.9      | 135.04         | 352.48     |
| #1-2018    | 3       | 2        | 3     | 2     | 3     | 8     | 13     | 11     | 14        | 7       | 11       | 4        | 81             |            |
| Cost       | 7.32    | 4.88     | 7.32  | 4.88  | 7.32  | 19.52 | 31.72  | 26.84  | 34.16     | 17.08   | 26.84    | 9.76     | 197.64         | 414.9      |
| #2-2010    | 12      | 11       | 12    | 12    | 22    | 40    | 62     | 67     | 62        | 57      | 27       | 10       | 394            |            |
| Cost       | 22.68   | 20.79    | 22.68 | 22.68 | 41.58 | 75.6  | 117.18 | 126.63 | 117.18    | 107.73  | 51.03    | 18.9     | 744.66         | 1651.76    |
| #2-2015    | 16      | 12       | 14    | 20    | 21    | 42    | 60     | 54     | 47        | 36      | 11       | 9        | 342            |            |
| Cost       | 35.32   | 25.24    | 30.28 | 45.4  | 47.92 | 102.1 | 158.65 | 124.2  | 108.1     | 82.8    | 25.3     | 20.7     | 806.01         | 1415.04    |
| #2-2018    | 16      | 12       | 13    | 6     | 20    | 24    | 46     | 47     | 45        | 31      | 22       | 16       | 298            |            |
| Cost       | 39.04   | 29.28    | 31.72 | 14.64 | 48.8  | 58.56 | 112.24 | 114.68 | 109.8     | 75.64   | 53.68    | 39.04    | 727.12         | 1196.72    |
| #3-2010    | 7       | 8        | 7     | 8     | 25    | 28    | 29     | 41     | 29        | 25      | 12       | 8        | 227            |            |
| Cost       | 13.23   | 15.12    | 13.23 | 15.12 | 47.25 | 52.92 | 54.81  | 77.49  | 54.81     | 47.25   | 22.68    | 15.12    | 429.03         | 997.42     |
| #3-2015    | 9       | 3        | 5     | 11    | 23    | 21    | 23     | 28     | 30        | 34      | 20       | 6        | 213            |            |
| Cost       | 18.18   | 6.06     | 10.1  | 22.72 | 52.96 | 47.92 | 52.96  | 64.4   | 69        | 78.2    | 46       | 13.8     | 482.3          | 916.26     |
| #3-2018    | 12      | 9        | 7     | 7     | 24    | 39    | 43     | 55     | 64        | 41      | 34       | 21       | 356            |            |
| Cost       | 29.28   | 21.96    | 17.08 | 17.08 | 58.56 | 95.16 | 104.92 | 134.2  | 156.16    | 100.04  | 82.96    | 51.24    | 868.64         | 1450.12    |
| #4-2010    | 11      | 12       | 10    | 8     | 21    | 24    | 24     | 21     | 8         | 10      | 12       | 11       | 172            |            |
| Cost       | 20.79   | 22.68    | 18.9  | 15.12 | 39.69 | 45.36 | 45.36  | 39.69  | 15.12     | 18.9    | 22.68    | 20.79    | 325.08         | 685.16     |
| #4-2015    | 2       | 2        | 5     | 4     | 5     | 23    | 12     | 23     | 8         | 1       | 1        | 1        | 87             |            |
| Cost       | 4.04    | 4.04     | 10.1  | 8.08  | 10.1  | 52.96 | 25.24  | 52.9   | 18.4      | 2.3     | 2.3      | 2.3      | 192.76         | 473.82     |
| #4-2018    | 1       | 1        | 1     | 2     | 2     | 14    | 33     | 29     | 22        | 16      | 9        | 9        | 139            |            |
| Cost       | 2.44    | 2.44     | 2.44  | 4.88  | 4.88  | 34.16 | 80.52  | 70.76  | 53.68     | 39.04   | 21.96    | 21.96    | 339.16         | 477.66     |
| #5-2010    | 8       | 8        | 7     | 7     | 7     | 20    | 25     | 21     | 10        | 13      | 7        | 8        | 141            |            |
| Cost       | 15.12   | 15.12    | 13.23 | 13.23 | 13.23 | 37.8  | 47.25  | 39.69  | 18.9      | 24.57   | 13.23    | 15.12    | 266.49         | 612.42     |
| #5-2015    | 10      | 7        | 6     | 8     | 7     | 7     | 6      | 9      | 5         | 9       | 7        | 9        | 90             |            |
| Cost       | 20.2    | 14.14    | 12.12 | 16.16 | 14.14 | 14.14 | 12.12  | 20.7   | 11.5      | 20.7    | 16.1     | 11.5     | 183.52         | 368.88     |
| #5-2018    | 7       | 7        | 7     | 8     | 7     | 5     | 5      | 8      | 7         | 7       | 7        | 8        | 83             |            |
| Cost       | 17.08   | 17.08    | 17.08 | 19.52 | 17.08 | 12.2  | 12.2   | 19.52  | 17.08     | 17.08   | 17.08    | 19.52    | 202.52         | 343.66     |
| #6-2010    | 5       | 5        | 4     | 4     | 15    | 15    | 33     | 34     | 33        | 32      | 6        | 7        | 193            |            |
| Cost       | 9.45    | 9.45     | 7.56  | 7.56  | 28.35 | 28.35 | 62.37  | 64.26  | 62.37     | 60.48   | 11.34    | 13.23    | 364.77         | 910.58     |
| #6-2015    | 2       | 13       | 15    | 27    | 18    | 16    | 21     | 41     | 34        | 26      | 16       | 8        | 237            |            |
| Cost       | 4.04    | 27.76    | 32.8  | 63.04 | 40.36 | 35.32 | 47.92  | 94.3   | 78.2      | 59.8    | 36.8     | 18.4     | 538.74         | 925.38     |
| #6-2018    | 10      | 6        | 8     | 5     | 10    | 21    | 29     | 31     | 33        | 29      | 15       | 13       | 210            |            |
| Cost       | 24.4    | 14.64    | 19.52 | 12.2  | 24.4  | 51.24 | 70.76  | 75.64  | 80.52     | 70.76   | 36.6     | 31.72    | 512.4          | 890.64     |
| #7-2010    | 1       | 1        | 2     | 2     | 4     | 5     | 3      | 3      | 2         | 2       | 2        | 1        | 28             |            |
| Cost       | 1.89    | 1.89     | 3.78  | 3.78  | 7.56  | 9.45  | 5.67   | 5.67   | 3.78      | 3.78    | 3.78     | 1.89     | 52.92          | 219.56     |
| #7-2015    | 3       | 1        | 1     | 1     | 1     | 2     | 2      | 3      | 2         | 3       | 2        | 2        | 23             |            |
| Cost       | 6.06    | 2.02     | 2.02  | 2.02  | 2.02  | 4.04  | 4.04   | 6.9    | 4.6       | 3.9     | 4.6      | 4.6      | 46.82          | 192.22     |
| #7-2018    | 2       | 2        | 3     | 3     | 3     | 3     | 3      | 3      | 4         | 4       | 4        | 3        | 37             |            |
| Cost       | 4.88    | 4.88     | 7.32  | 7.32  | 7.32  | 7.32  | 7.32   | 7.32   | 9.76      | 9.76    | 9.76     | 7.32     | 90.28          | 231.14     |
| #8-2010    | 3       | 3        | 3     | 4     | 8     | 8     | 6      | 5      | 4         | 4       | 3        | 3        | 54             |            |
| Cost       | 5.67    | 5.67     | 5.67  | 7.56  | 15.12 | 15.12 | 11.34  | 9.45   | 7.56      | 7.56    | 5.67     | 5.67     | 102.06         | 303.36     |
| #8-2015    | 5       | 3        | 4     | 4     | 6     | 6     | 6      | 10     | 17        | 7       | 6        | 2        | 76             |            |
| Cost       | 10.1    | 6.06     | 8.08  | 8.08  | 12.12 | 12.12 | 12.12  | 23     | 39.1      | 16.1    | 13.8     | 4.6      | 165.28         | 387.56     |
| #8-2018    | 14      | 15       | 15    | 17    | 18    | 21    | 22     | 30     | 34        | 23      | 17       | 7        | 233            |            |
| Cost       | 34.16   | 36.6     | 36.6  | 41.48 | 43.92 | 51.24 | 53.68  | 73.2   | 82.96     | 56.12   | 41.48    | 17.08    | 568.52         | 891.22     |
| #9-2010    | 11      | 9        | 7     | 9     | 4     | 6     | 9      | 33     | 29        | 29      | 24       | 13       | 183            |            |
| Cost       | 20.79   | 17.01    | 13.23 | 17.01 | 7.56  | 11.34 | 17.01  | 62.37  | 54.81     | 54.81   | 45.36    | 24.57    | 345.87         | 702.3      |
| #9-2015    | 10      | 8        | 7     | 8     | 6     | 6     | 12     | 7      | 8         | 10      | 7        | 5        | 94             |            |
| Cost       | 20.2    | 16.16    | 14.14 | 16.16 | 12.12 | 12.12 | 25.24  | 16.1   | 18.4      | 23      | 16.1     | 11.5     | 201.24         | 391.52     |
| #9-2018    | 6       | 11       | 8     | 10    | 8     | 12    | 19     | 23     | 23        | 9       | 14       | 10       | 153            |            |
| Cost       | 14.64   | 26.84    | 19.52 | 24.4  | 19.52 | 29.28 | 46.36  | 56.12  | 56.12     | 21.96   | 34.16    | 24.4     | 373.32         | 615.06     |
| #10-2010   | 6       | 6        | 5     | 7     | 7     | 8     | 21     | 22     | 26        | 24      | 9        | 9        | 150            |            |
| Cost       | 11.34   | 11.34    | 9.45  | 13.23 | 13.23 | 15.12 | 39.69  | 41.58  | 49.14     | 45.36   | 17.01    | 17.01    | 283.5          | 666.24     |
| #10-2015   | 5       | 8        | 8     | 2     | 1     | 1     | 1      | 2      | 4         | 1       | 1        | 2        | 36             |            |
| Cost       | 10.1    | 16.16    | 16.16 | 4.04  | 2.02  | 2.02  | 2.02   | 4.6    | 9.2       | 2.3     | 2.3      | 4.6      | 75.52          | 191.88     |
| #10-2018   | 4       | 5        | 4     | 4     | 5     | 5     | 4      | 4      | 5         | 4       | 4        | 5        | 53             |            |
| Cost       | 9.76    | 12.2     | 9.76  | 9.76  | 12.2  | 12.2  | 9.76   | 9.76   | 12.2      | 9.76    | 9.76     | 12.2     | 129.32         | 271.78     |
| #11-2010   | 8       | 5        | 5     | 5     | 6     | 22    | 36     | 57     | 59        | 8       | 8        | 16       | 235            |            |
| Cost       | 15.12   | 9.45     | 9.45  | 9.45  | 11.34 | 41.58 | 68.04  | 107.73 | 111.51    | 15.12   | 15.12    | 30.24    | 444.15         | 1046.54    |
| #11-2015   | 4       | 4        | 4     | 3     | 3     | 10    | 11     | 20     | 27        | 18      | 9        | 8        | 121            |            |
| Cost       | 8.08    | 8.08     | 8.08  | 6.06  | 6.06  | 20.2  | 22.72  | 46     | 62.1      | 41.4    | 20.7     | 18.4     | 267.88         | 568.34     |

|          |       |       |       |       |       |       |       |        |        |        |       |       |        |         |
|----------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|-------|-------|--------|---------|
| #11-2018 | 4     | 4     | 5     | 4     | 4     | 12    | 35    | 35     | 45     | 31     | 26    | 12    | 217    |         |
| Cost     | 9.76  | 9.76  | 12.2  | 9.76  | 9.76  | 29.28 | 85.4  | 85.4   | 109.8  | 75.64  | 63.44 | 29.28 | 529.48 | 931.22  |
| #12-2010 | 5     | 6     | 6     | 4     | 6     | 5     | 10    | 10     | 15     | 15     | 6     | 5     | 93     |         |
| Cost     | 9.45  | 11.34 | 11.34 | 7.56  | 11.34 | 9.45  | 18.9  | 18.9   | 28.35  | 28.35  | 11.34 | 9.45  | 175.77 | 436.24  |
| #12-2015 | 4     | 3     | 4     | 4     | 3     | 3     | 3     | 5      | 3      | 2      | 3     | 3     | 40     |         |
| Cost     | 8.08  | 6.06  | 8.08  | 8.08  | 6.06  | 6.06  | 6.06  | 11.5   | 6.9    | 4.6    | 6.9   | 6.9   | 85.28  | 229.88  |
| #12-2018 | 4     | 3     | 3     | 4     | 3     | 4     | 4     | 3      | 4      | 2      | 3     | 3     | 40     |         |
| Cost     | 9.76  | 7.32  | 7.32  | 9.76  | 7.32  | 9.76  | 9.76  | 7.32   | 9.76   | 4.88   | 7.32  | 7.32  | 97.6   | 233.72  |
| #13-2010 | 4     | 3     | 7     | 2     | 4     | 4     | 5     | 6      | 6      | 6      | 4     | 2     | 53     |         |
| Cost     | 7.56  | 5.67  | 13.23 | 3.78  | 7.56  | 7.56  | 9.45  | 11.34  | 11.34  | 11.34  | 7.56  | 3.78  | 100.17 | 287.14  |
| #13-2015 | 3     | 2     | 3     | 2     | 3     | 3     | 3     | 3      | 3      | 3      | 3     | 2     | 33     |         |
| Cost     | 6.06  | 4.04  | 6.06  | 4.04  | 6.06  | 6.06  | 6.06  | 6.9    | 6.9    | 6.9    | 6.9   | 4.6   | 70.58  | 220.02  |
| #13-2018 | 2     | 2     | 2     | 2     | 2     | 2     | 3     | 2      | 2      | 2      | 2     | 2     | 25     |         |
| Cost     | 4.88  | 4.88  | 4.88  | 4.88  | 4.88  | 7.32  | 4.88  | 4.88   | 4.88   | 4.88   | 4.88  | 4.88  | 61     | 193.94  |
| #14-2010 | 2     | 4     | 3     | 6     | 6     | 6     | 15    | 17     | 13     | 11     | 5     | 2     | 90     |         |
| Cost     | 3.78  | 7.56  | 5.67  | 11.34 | 11.34 | 11.34 | 28.35 | 32.13  | 24.57  | 20.79  | 9.45  | 3.78  | 170.1  | 461.04  |
| #14-2015 | 2     | 6     | 4     | 5     | 6     | 7     | 7     | 12     | 9      | 8      | 5     | 1     | 72     |         |
| Cost     | 4.04  | 12.12 | 8.08  | 10.1  | 12.12 | 14.14 | 14.14 | 27.6   | 20.7   | 18.4   | 11.5  | 2.3   | 155.24 | 372.6   |
| #14-2018 | 3     | 3     | 3     | 5     | 5     | 5     | 9     | 10     | 10     | 5      | 5     | 4     | 67     |         |
| Cost     | 7.32  | 7.32  | 7.32  | 12.2  | 12.2  | 12.2  | 21.96 | 48.8   | 48.8   | 12.2   | 12.2  | 9.76  | 212.28 | 349.1   |
| #15-2010 | 4     | 11    | 12    | 8     | 8     | 12    | 12    | 11     | 11     | 6      | 6     | 5     | 106    |         |
| Cost     | 7.56  | 20.79 | 22.68 | 15.12 | 15.12 | 22.68 | 22.68 | 20.79  | 20.79  | 11.4   | 11.4  | 9.45  | 200.46 | 444.08  |
| #15-2015 | 5     | 4     | 5     | 2     | 4     | 18    | 13    | 23     | 18     | 11     | 5     | 3     | 111    |         |
| Cost     | 10.1  | 8.08  | 10.1  | 4.04  | 8.08  | 40.36 | 27.76 | 52.9   | 41.4   | 25.3   | 11.5  | 6.9   | 246.52 | 552.06  |
| #15-2018 | 8     | 6     | 4     | 3     | 5     | 16    | 20    | 30     | 29     | 13     | 20    | 2     | 156    |         |
| Cost     | 19.52 | 14.64 | 9.76  | 7.32  | 12.2  | 39.04 | 48.8  | 73.2   | 70.76  | 31.72  | 48.8  | 4.88  | 380.64 | 690.6   |
| #16-2010 | 4     | 4     | 4     | 5     | 6     | 6     | 7     | 6      | 6      | 5      | 6     | 4     | 63     |         |
| Cost     | 7.56  | 7.56  | 7.56  | 7.56  | 11.4  | 11.4  | 13.23 | 11.4   | 11.4   | 9.45   | 11.4  | 7.56  | 117.48 | 314.94  |
| #16-2015 | 2     | 4     | 4     | 3     | 2     | 4     | 5     | 6      | 3      | 3      | 2     | 2     | 40     |         |
| Cost     | 4.04  | 8.08  | 8.08  | 6.06  | 4.04  | 8.08  | 10.1  | 13.8   | 6.9    | 6.9    | 4.6   | 4.6   | 85.28  | 245.24  |
| #16-2018 | 3     | 2     | 4     | 4     | 3     | 5     | 8     | 7      | 7      | 4      | 10    | 3     | 60     |         |
| Cost     | 7.32  | 4.88  | 9.76  | 9.76  | 7.32  | 12.2  | 19.52 | 17.08  | 17.08  | 9.76   | 24.4  | 7.32  | 146.4  | 304.68  |
| #17-2010 | 7     | 7     | 8     | 8     | 17    | 19    | 23    | 22     | 24     | 24     | 13    | 11    | 183    |         |
| Cost     | 13.23 | 13.23 | 15.12 | 15.12 | 32.13 | 35.91 | 43.47 | 41.58  | 45.36  | 45.36  | 24.57 | 20.79 | 345.87 | 775.26  |
| #17-2015 | 8     | 8     | 6     | 8     | 12    | 12    | 18    | 16     | 14     | 13     | 11    | 9     | 135    |         |
| Cost     | 16.16 | 16.16 | 12.12 | 16.16 | 25.24 | 25.24 | 40.36 | 36.8   | 32.2   | 29.9   | 25.3  | 20.7  | 296.34 | 565.02  |
| #17-2018 | 11    | 9     | 8     | 10    | 15    | 24    | 22    | 26     | 23     | 16     | 17    | 14    | 195    |         |
| Cost     | 26.84 | 21.96 | 19.52 | 24.4  | 36.6  | 58.56 | 53.68 | 63.44  | 56.12  | 39.04  | 41.48 | 34.16 | 475.8  | 774.06  |
| #18-2010 | 3     | 2     | 2     | 2     | 2     | 3     | 3     | 4      | 3      | 1      | 2     | 3     | 30     |         |
| Cost     | 5.67  | 3.78  | 3.78  | 3.78  | 3.78  | 5.67  | 5.67  | 7.56   | 5.67   | 1.89   | 3.78  | 5.67  | 56.7   | 209.76  |
| #18-2015 | 1     | 1     | 3     | 2     | 2     | 2     | 3     | 3      | 5      | 7      | 4     | 5     | 38     |         |
| Cost     | 2.02  | 2.02  | 6.06  | 4.04  | 4.04  | 4.04  | 6.06  | 6.9    | 11.5   | 16.1   | 9.2   | 11.5  | 83.48  | 239.68  |
| #18-2018 | 6     | 5     | 4     | 6     | 4     | 6     | 7     | 11     | 11     | 9      | 6     | 5     | 80     |         |
| Cost     | 14.64 | 12.2  | 9.76  | 14.64 | 9.76  | 14.64 | 17.08 | 26.84  | 26.84  | 21.96  | 14.64 | 12.2  | 195.2  | 375.64  |
| #19-2010 | 3     | 2     | 2     | 3     | 6     | 19    | 14    | 14     | 17     | 18     | 11    | 4     | 113    |         |
| Cost     | 5.67  | 3.78  | 3.78  | 5.67  | 11.34 | 35.91 | 26.46 | 26.46  | 32.13  | 34.02  | 20.79 | 7.56  | 213.57 | 557.62  |
| #19-2015 | 2     | 2     | 2     | 6     | 5     | 6     | 9     | 10     | 11     | 15     | 8     | 4     | 80     |         |
| Cost     | 4.04  | 4.04  | 4.04  | 12.12 | 10.1  | 12.12 | 18.18 | 23     | 25.3   | 34.5   | 18.4  | 9.2   | 175.04 | 406.36  |
| #19-2018 | 4     | 4     | 2     | 4     | 9     | 13    | 11    | 19     | 15     | 11     | 8     | 5     | 105    |         |
| Cost     | 9.76  | 9.76  | 4.88  | 9.76  | 21.96 | 31.72 | 26.84 | 46.36  | 36.6   | 26.84  | 19.52 | 12.2  | 256.2  | 512.34  |
| #20-2010 | 7     | 6     | 7     | 8     | 6     | 8     | 9     | 8      | 11     | 9      | 8     | 7     | 94     |         |
| Cost     | 13.23 | 11.34 | 13.23 | 15.12 | 11.34 | 15.12 | 17.01 | 15.12  | 20.79  | 17.01  | 15.12 | 13.23 | 177.66 | 399.92  |
| #20-2015 | 7     | 6     | 4     | 7     | 4     | 4     | 9     | 7      | 6      | 6      | 5     | 5     | 70     |         |
| Cost     | 14.14 | 12.12 | 8.08  | 14.14 | 8.08  | 8.08  | 18.18 | 16.1   | 13.8   | 13.8   | 11.5  | 11.5  | 149.52 | 320.96  |
| #20-2018 | 6     | 4     | 7     | 4     | 5     | 9     | 12    | 13     | 12     | 6      | 9     | 6     | 93     |         |
| Cost     | 14.64 | 9.76  | 17.08 | 9.76  | 12.2  | 21.96 | 29.28 | 31.72  | 29.28  | 14.64  | 21.96 | 14.64 | 226.92 | 425.22  |
| #21-2010 | 7     | 7     | 9     | 7     | 17    | 32    | 42    | 104    | 109    | 102    | 16    | 9     | 461    |         |
| Cost     | 13.23 | 13.23 | 17.01 | 13.23 | 32.13 | 28.48 | 79.38 | 196.46 | 206.01 | 192.78 | 30.24 | 17.01 | 839.19 | 2078.02 |
| #21-2015 | 8     | 6     | 9     | 12    | 21    | 18    | 34    | 27     | 22     | 19     | 16    | 15    | 207    |         |
| Cost     | 16.16 | 12.12 | 18.18 | 25.24 | 47.92 | 40.36 | 80.68 | 62.1   | 50.6   | 43.7   | 36.8  | 34.5  | 468.36 | 841.98  |
| #21-2018 | 7     | 7     | 4     | 8     | 5     | 16    | 26    | 31     | 20     | 19     | 13    | 9     | 165    |         |
| Cost     | 17.08 | 17.08 | 9.76  | 19.52 | 12.2  | 39.04 | 63.44 | 75.64  | 48.8   | 46.36  | 31.72 | 21.96 | 402.6  | 713.7   |
| #22-2010 | 5     | 5     | 9     | 9     | 3     | 2     | 3     | 4      | 6      | 7      | 5     | 6     | 64     |         |
| Cost     | 9.45  | 9.45  | 17.01 | 17.01 | 5.67  | 3.78  | 3.78  | 7.56   | 11.34  | 13.23  | 9.45  | 11.34 | 119.07 | 273.56  |
| #22-2015 | 2     | 2     | 1     | 1     | 1     | 4     | 3     | 2      | 2      | 1      | 1     | 2     | 22     |         |
| Cost     | 4.04  | 4.04  | 2.02  | 2.02  | 2.02  | 8.08  | 6.06  | 4.6    | 4.6    | 2.3    | 2.3   | 4.6   | 46.68  | 191.36  |
| #22-2018 | 2     | 1     | 2     | 1     | 1     | 2     | 1     | 2      | 2      | 2      | 1     | 2     | 19     |         |
| Cost     | 4.88  | 2.44  | 4.88  | 2.44  | 2.44  | 4.88  | 2.44  | 4.88   | 4.88   | 4.88   | 2.44  | 4.88  | 46.36  | 177.26  |
| #23-2010 | 12    | 12    | 23    | 26    | 14    | 19    | 34    | 20     | 30     | 13     | 12    | 12    | 227    |         |
| Cost     | 22.68 | 22.68 | 43.47 | 49.14 | 26.46 | 35.91 | 64.26 | 37.8   | 56.7   | 24.57  | 22.68 | 22.68 | 429.03 | 816.94  |
| #23-2015 | 4     | 4     | 4     | 7     | 3     | 4     | 11    | 14     | 12     | 10     | 10    | 5     | 88     |         |
| Cost     | 8.08  | 8.08  | 8.08  | 14.14 | 6.06  | 8.08  | 22.72 | 32.2   | 27.6   | 23     | 23    | 11.5  | 192.54 | 405.56  |
| #23-2018 | 3     | 2     | 3     | 6     | 8     | 3     | 10    | 11     | 23     | 15     | 15    | 8     | 107    |         |
| Cost     | 7.32  | 4.88  | 7.32  | 14.64 | 19.52 | 7.32  | 24.4  | 26.84  | 56.12  | 36.6   | 36.6  | 19.52 | 261.08 | 483.34  |

|          |       |       |       |       |       |       |       |       |       |       |       |       |        |        |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|
| #24-2010 | 10    | 9     | 10    | 11    | 23    | 20    | 33    | 38    | 36    | 33    | 9     | 9     | 241    |        |
| Cost     | 18.9  | 17.01 | 18.9  | 20.79 | 43.37 | 37.8  | 62.37 | 71.82 | 68.04 | 62.37 | 17.01 | 17.01 | 455.39 | 1032.5 |
| #24-2015 | 8     | 8     | 8     | 13    | 15    | 17    | 24    | 22    | 20    | 23    | 14    | 7     | 179    |        |
| Cost     | 16.16 | 16.16 | 16.16 | 27.76 | 32.8  | 37.84 | 55.48 | 50.6  | 46    | 52.9  | 32.2  | 16.1  | 400.16 | 741.1  |
| #24-2018 | 9     | 9     | 5     | 10    | 16    | 27    | 27    | 30    | 37    | 24    | 22    | 14    | 230    |        |
| Cost     | 21.96 | 21.96 | 12.2  | 24.4  | 39.04 | 65.88 | 65.88 | 73.2  | 90.28 | 58.56 | 53.68 | 34.16 | 561.2  | 938.56 |
| #25-2010 | 1     | 1     | 2     | 2     | 2     | 3     | 3     | 4     | 5     | 6     | 2     | 2     | 33     |        |
| Cost     | 1.89  | 1.89  | 3.78  | 3.78  | 3.78  | 5.67  | 5.67  | 7.56  | 9.45  | 11.34 | 3.78  | 3.78  | 62.37  | 239.22 |
| #25-2015 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 5     | 6     | 4     | 4     | 4     | 23     |        |
| Cost     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 11.5  | 13.8  | 9.2   | 9.2   | 9.2   | 52.9   | 199.9  |
| #25-2018 | 1     | 1     | 2     | 2     | 3     | 3     | 2     | 3     | 2     | 2     | 3     | 2     | 26     |        |
| Cost     | 2.44  | 2.44  | 4.88  | 4.88  | 7.32  | 7.32  | 4.88  | 7.32  | 4.88  | 4.88  | 7.32  | 4.88  | 63.44  | 202.48 |